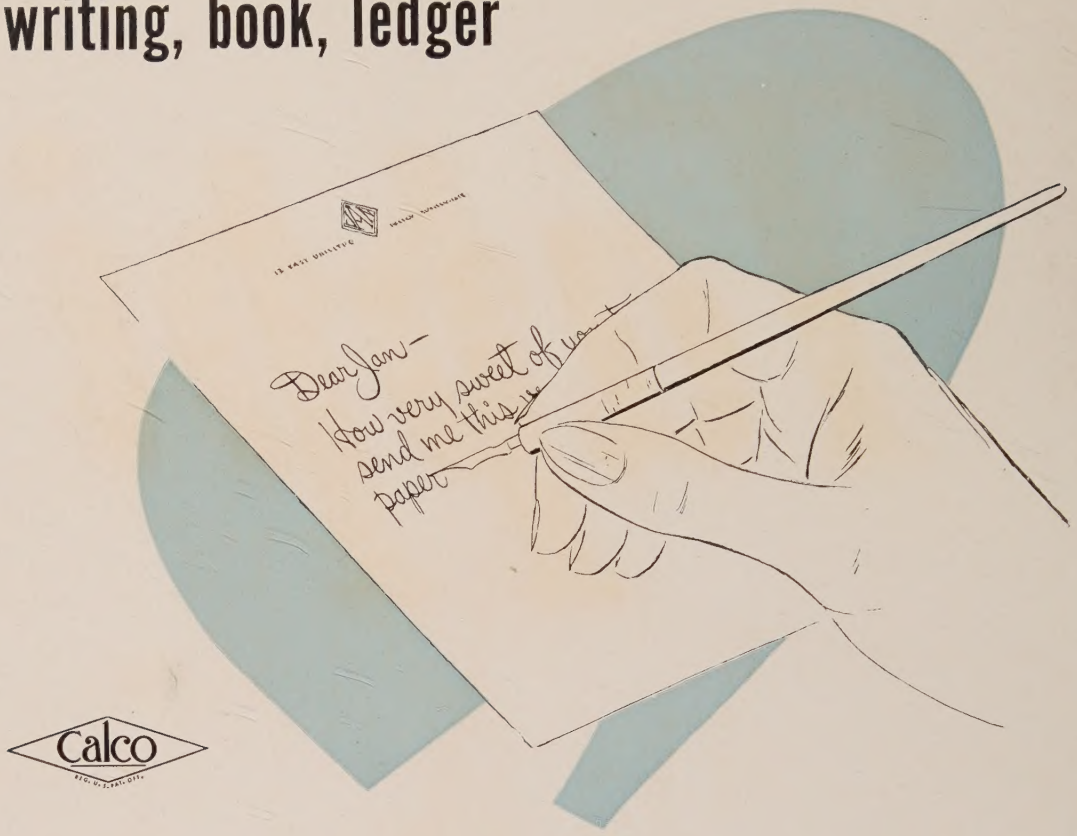
Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

APRIL 1950

for superior whiteness in bond, writing, book, ledger



Calco

HELMERCO BLUE

Wherever superior whiteness is required, in bond, writing, book and ledger, paper manufacturers have come to depend on HELMERCO BLUE to supply it. They find it has good working properties in the beater, and offers excellent light fastness. It also produces fine light blues in these same papers.

In the tinting of paper coatings, HELMERCO BLUES produce an excellent high white shade in any formula.

HELMERCO BLUES are available in a range of shades from red to green: M4R Conc., M2RW Conc., MGW Conc., MG Conc., M2GB Conc., M2G Conc., M4G Conc., and M5G.

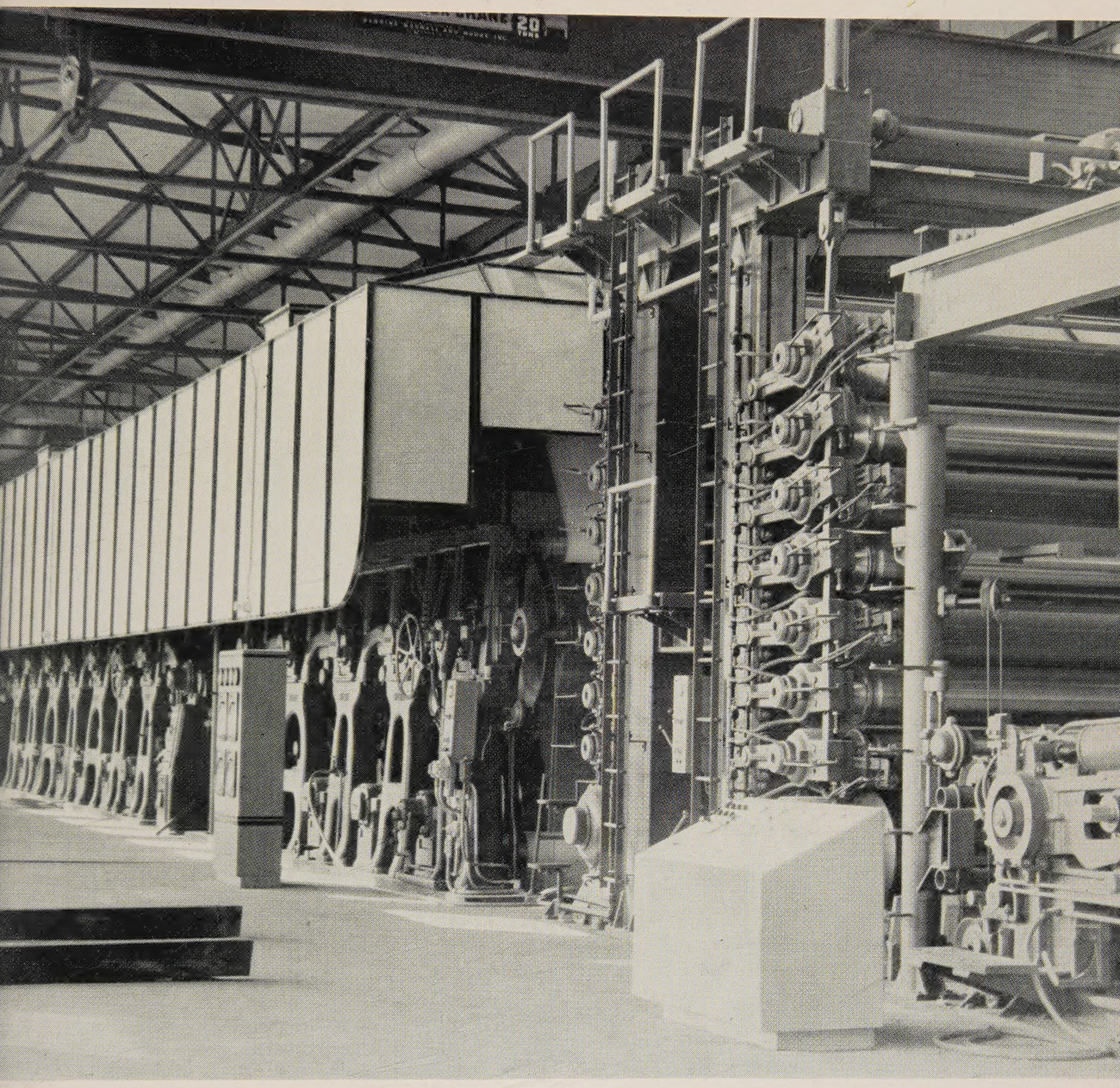
Let your Calco representative help you with any problems related to the coloring of paper.

AMERICAN *Cyanamid* COMPANY

CALCO CHEMICAL DIVISION,
Bound Brook, New Jersey

New York • Chicago • Boston • Philadelphia • Charlotte • Providence

Gulf States: kraft bag and wrapping



In the Gulf States Paper Corporation plant at Tuscaloosa, Ala., this modern 170″ Beloit High Speed Kraft machine—"The Warrior"—is turning out high-quality kraft bag and wrapping paper for the E-Z Opener Bag Company, Gulf States' Sales Division. All three machines in this mill are products of Beloit, the first built in 1901, the second in 1928. E-Z Opener Bag Company operated the 1901 machine at Braithwaite, La., before having it rebuilt by Beloit and moved to Tuscaloosa.—*Beloit Iron Works, Beloit, Wisconsin.*

BELOIT IRON WORKS · PAPER MACHINERY · BELOIT, WIS., U.S.A.

WHEN YOU BUY BELOIT... YOU BUY MORE THAN A MACHINE!

BELOIT

PAPER MACHINERY

COLOR... for eye-catching corrugated shipping containers

COLOR gets attention... makes any corrugated shipping container attractive. Immediately it is something *different*... something *distinguished* from the usual... something in demand. It takes a special place in the customer's mind.

You can profit from color by selling *more color*. Many of your customers need this low-cost way to distinguish their product to the retailer.

For information about dyes for corrugated shipping containers ...or for help on *any* coloring problem... consult our Technical Staff. E. I. du Pont de Nemours & Co. (Inc.), Dyestuffs Div., Wilmington 98, Del.

FOR MAXIMUM ECONOMY
Du Pont basic dyes

FOR MAXIMUM SOLUBILITY
Du Pont acid dyes

FOR ECONOMY AND LIGHT FASTNESS
Du Pont direct dyes

FOR MAXIMUM LIGHT FASTNESS
Du Pont dispersed organic pigments:

Monastral* Fast Blue BWD or BFP Paste
Monastral* Fast Green GWD or GFP Paste
Lithosol* Pigments
Halopont* Types

*Reg. U. S. Pat. Off.

More color makes more business ...for your customers and you

Du Pont Dyestuffs

DU PONT

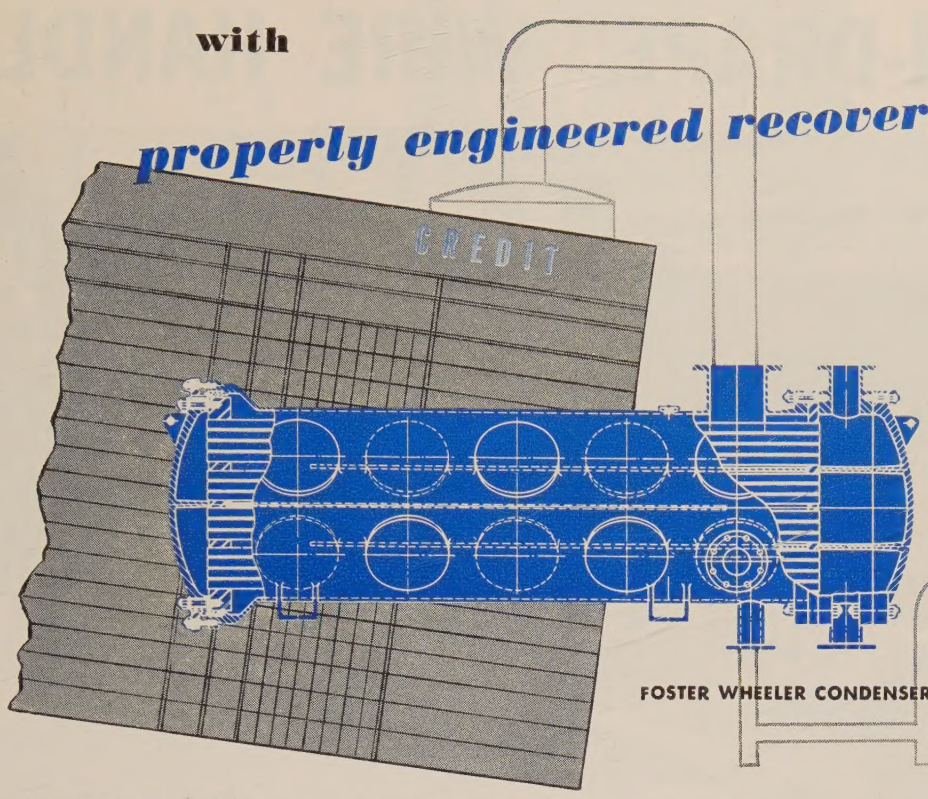
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING... *THROUGH CHEMISTRY*

adding a **PROFIT**

with

properly engineered recovery equipment



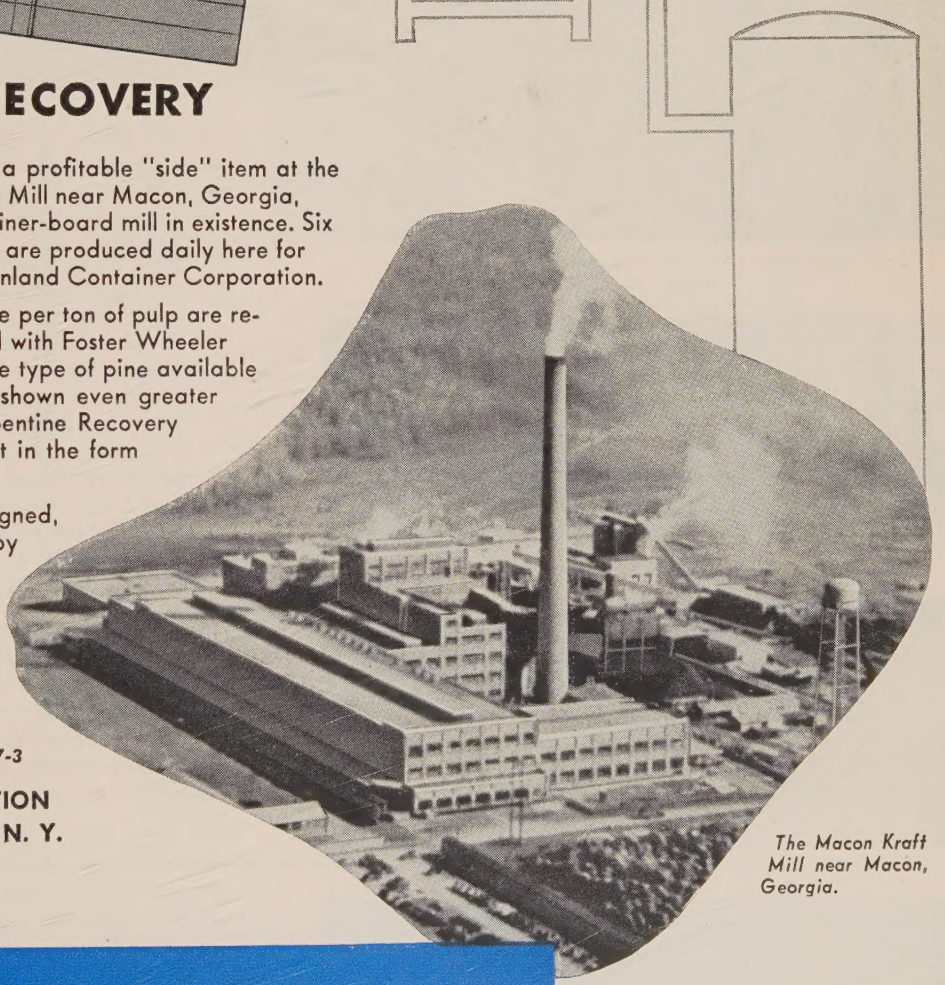
FOSTER WHEELER CONDENSER FOR TURPENTINE RECOVERY

TURPENTINE RECOVERY

Turpentine Recovery is proving a profitable "side" item at the completely modern Macon Kraft Mill near Macon, Georgia, the largest single-machine container-board mill in existence. Six hundred tons of container board are produced daily here for the Mead Corporation and the Inland Container Corporation.

Two to three gallons of turpentine per ton of pulp are recovered at the Macon Kraft Mill with Foster Wheeler equipment—a fine record for the type of pine available in the area. Other areas have shown even greater yields with Foster Wheeler Turpentine Recovery Systems which also recover heat in the form of hot mill water.

Other pulp mill equipment—designed, engineered, and constructed by Foster Wheeler—include Systems for Digester Blow Heat Recovery, Indirect Digester Heating, and Tall Oil Processing.



The Macon Kraft Mill near Macon, Georgia.

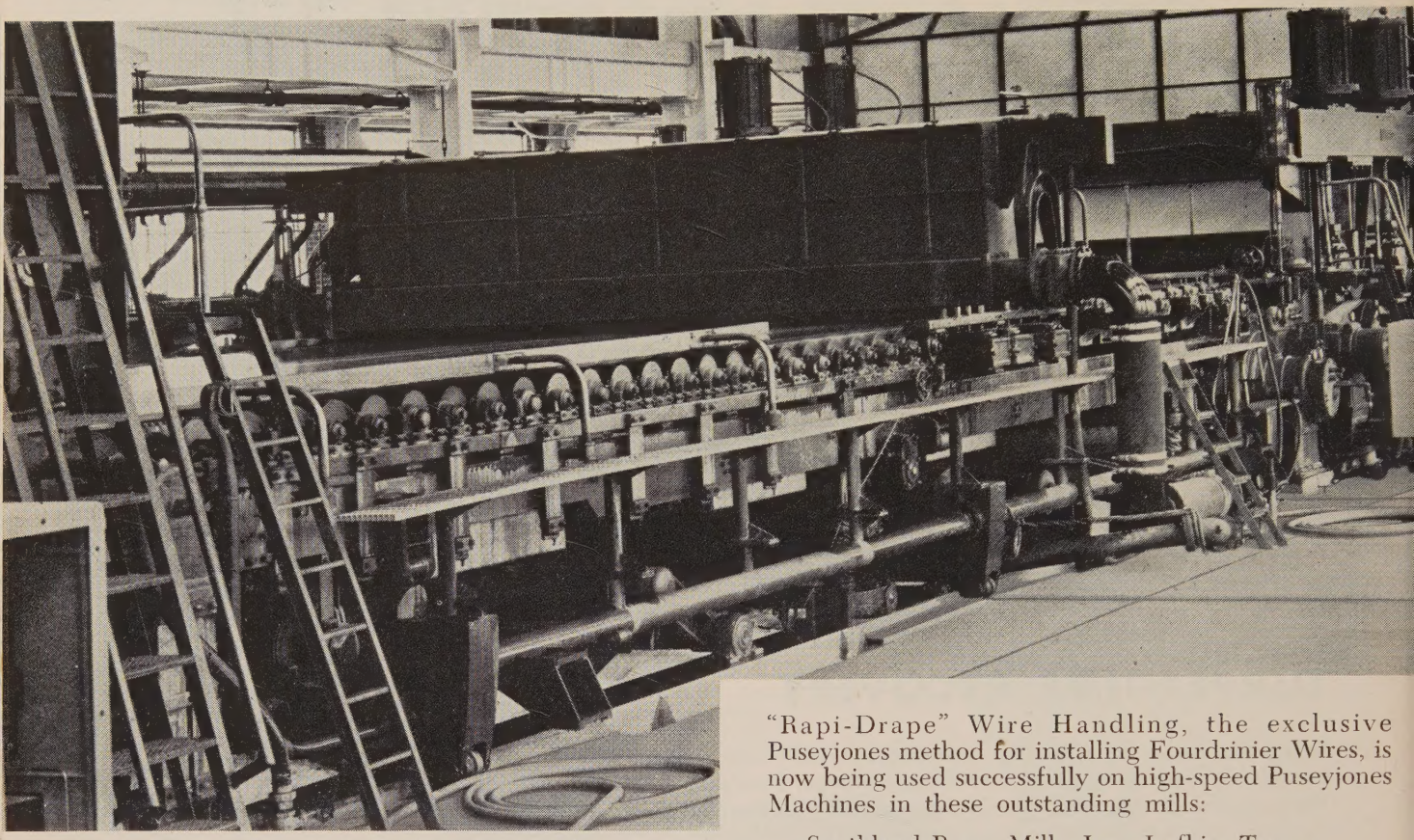
Write for bulletins 1D-47-13 and 1D-47-3

FOSTER WHEELER CORPORATION
165 Broadway, New York 6, N. Y.

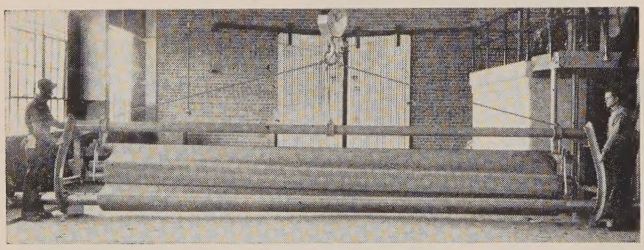
FOSTER WHEELER

Success Story

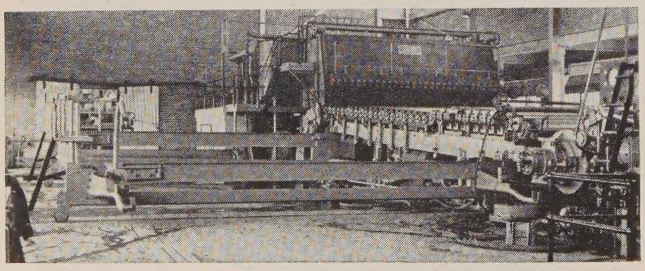
ON "RAPI-DRAPE" WIRE HANDLIN



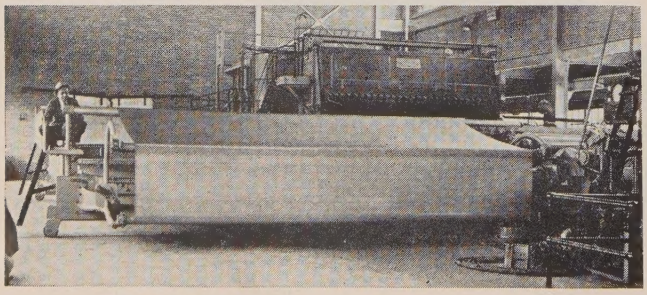
"Rapi-Drape" Puseyjones Fourdrinier Part suitable for a wire 236" wide, 120 ft. long.



Wire holder handled by crane.



Under-carriage in position ready to drape wire.



Wire draped on under-carriage ready to install.

"Rapi-Drape" Wire Handling, the exclusive Puseyjones method for installing Fourdrinier Wires, is now being used successfully on high-speed Puseyjones Machines in these outstanding mills:

Southland Paper Mills, Inc., Lufkin, Texas
Hollingsworth & Whitney Company, Mobile, Ala.
Southern Advance Bag & Paper Co., Hodge, La.
St. Mary's Kraft Corp., St. Mary's, Ga.
Union Bag & Paper Corp., Savannah, Ga.
Hudson Pulp & Paper Co., Palatka, Florida
Southern Paper Board Corp., Port Wentworth, Ga.
Fibreboard Products, Inc., East Antioch, Cal.
St. Regis Paper Co., Tacoma, Wash.
Calcasieu Paper Co., Elizabeth, La.
San Rafael Paper Co., Mexico, D. F.
Papierfabrik Utzenstorf, Switzerland
National Newsprint Co., Ltd., India

The results in terms of fast, safe wire handling are acclaimed by the responsible operators and engineers. There are no heavy parts to handle. The Fourdrinier part remains in perfect alignment at all times, adequately supported at front and back. No danger of deflection stresses and distortion as experienced with complete removal or cantilever change.

Be sure that your next machine is equipped with "Rapi-Drape" Wire Handling – one of many design improvements and labor saving devices pioneered by Puseyjones.

THE PUSEY AND JONES CORPORATION
Established 1848. Builders of Paper-making Machinery
Wilmington, Delaware, U.S.A.

THE SIGN OF TRADE MARK SUPERIOR QUALITY

APRIL 1950

Tappi

VOL. 33 · NO. 4

Published monthly by the Technical Association of the Pulp and Paper Industry

Editor
R. G. MACDONALD

Assistant Editor
R. T. Bingham

Publication Management Committee
K. P. Geohegan, *Chairman*
H. W. Bialkowsky
Werner Kaufmann
R. W. Kumler
R. P. Price

Editorial Board
C. J. West, *Chairman*
S. I. Aronovsky
J. F. Campbell
J. d'A. Clark
E. L. Cowan
R. F. DeLong
A. S. Erspamer
R. C. Griffin
W. D. Harrison
Emil Heuser
W. F. Holzer
E. C. Jahn
H. F. Lewis
J. D. Malcolmson
H. Mark
A. E. Montgomery
D. G. Moon
J. L. Parsons
Henry Perry
A. L. Sherwood
Edwin Sutermeister
G H. Tomlinson II
B. L. Wehmhoff

TECHNICAL ARTICLES

The Manufacture of Chemigroundwood Pulp from Hardwoods, *by C. E. Libby and F. W. O'Neil* 161

Permanence of Wet Strength Paper, *by C. S. Maxwell and W. F. Reynolds* 179

Wax from Douglas-Fir Bark, *by E. F. Kurth and H. J. Kiefer* .. 183

Magnesia-Base Sulphite Pulping—A Progress Report, *by R. E. Baker and L. S. Wilcoxson* 187

The Beta-Ray Basis Weight Gage, *by E. A. Crawford and M. Strain* 190

Revolving Disk Mills in Straw Pulp Production, *by C. K. Textor and L. E. Eberhardt* 193

Recovery of Waste Heat in Pulp and Paper Mills, *by D. K. Dean* 195

The Rheology of Paper Coatings, *by William R. Willets* 201

DEPARTMENTS

Pulp, Paper, and Paperboard in the United States—Review for 1949 ..... 14 A

Personal Mention ..... 37 A

Employment Services ..... 44 A

Association News and Events ..... 46 A

Local Section Activities ..... 50 A

Letters to the Editor ..... 56 A

Reports and Discussions ..... 60 A

Status of the Pacific Coast Pulp and Paper Industry, *by Lawson Turcotte* ..... 70 A

Hydraulic Barking—A Summary, *by L. E. Hill* ..... 72 A

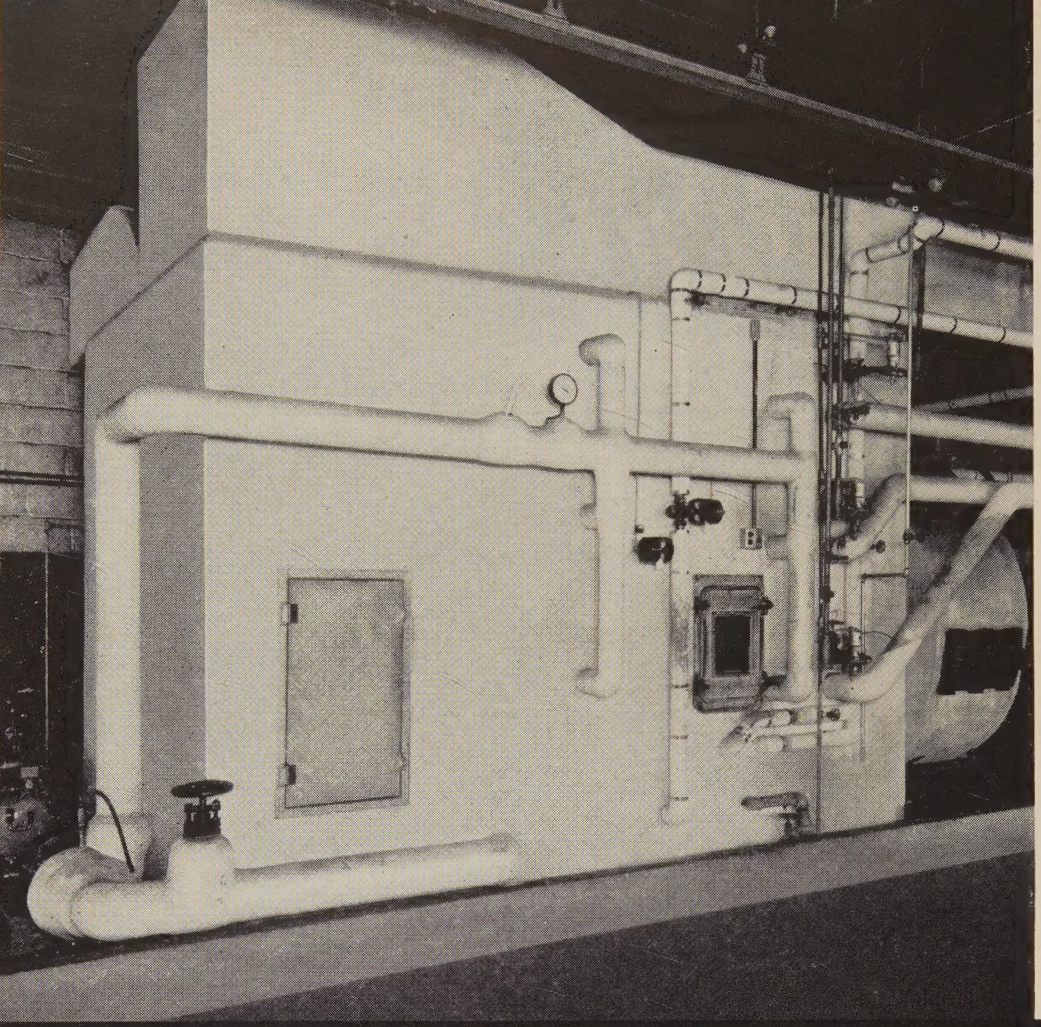
Education and the Paper Industry, *by John G. Strange* ..... 82 A

The Beater Addition Process for Producing Laminating Papers, *by F. H. Snyder, L. Spiwak, and A. E. Moyer* ..... 87 A

Recent Books ..... 90 A

Calendar of TAPPI Meetings ..... 91 A

Published monthly by the Technical Association of the Pulp and Paper Industry at 20th and Northampton Streets, Easton, Pa. Editorial and advertising offices, 122 East 42nd Street, New York 17, N. Y. Articles for publication and communications regarding the editorial content of *Tappi* should be addressed to the Editor at the editorial office. Statements and opinions expressed in articles and editorials appearing in *Tappi* are those of the contributors, and the Technical Association of the Pulp and Paper Industry assumes no responsibility for them. Subscription: U. S. and possessions, $7.50; Canada, $8.25; Pan American Union, $9.00; Other Foreign, $10.00. Single copies to members of TAPPI, $0.75; Nonmembers, $1.00. Entered as second class matter January 27, 1949, at the Post Office at Easton, Pa., under the act of August 24, 1912. Copyright, 1950, by the Technical Association of the Pulp and Paper Industry. An index of the technical articles appearing in the magazine appears in the Industrial Arts Index and the Engineering Index.



How Can AIR CONDITIONING BENEFIT YOUR PLANT?

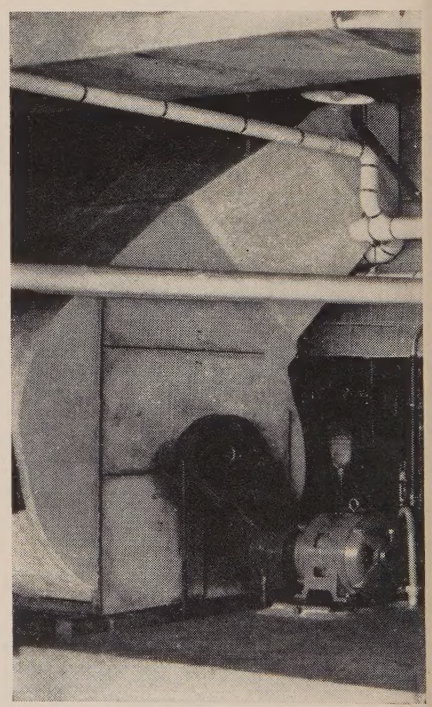
Here's how it's Helping Thousands of "BUFFALO" USERS

● IMPROVED QUALITY
Often the most economical way of keeping your air dust-free and properly tempered—and product processing at its best—is with "Buffalo" Air Washers or Air Conditioning Cabinets. Every day new processes are made more efficient through positive "Buffalo" air control. "Buffalo" equipment is ready to give you ANY air conditions you require.

● BETTER INDUSTRIAL RELATIONS
The emphasis placed today on air control for safe, healthy working conditions is well-founded! Cleaner, healthier air means less absenteeism and a lower accident rate. "Buffalo" equipment is one of your EASIEST means of promoting good industrial relations—and extra profits!

● STEPPED UP PRODUCTION
Employees as well as processes are more productive in an atmosphere that's always fresh, always clean, always comfortable as to temperature and humidity! A complete line of "Buffalo" equipment can give you this "production bonus"—economically—as in literally thousands of installations today.

NOTE: Often all the "air conditioning" your plant needs MAY be handled by fans. "Buffalo" Fans and Exhausters are used throughout the world for cooling, supplying fresh air and removing dust, heat and fumes. Write us your problem, for unbiased recommendations!



IT COSTS YOU NOTHING TO GET THE FACTS!
Simply write us or call your nearby "Buffalo" Engineering Representative for advice on your air problems!

Fans and Air Conditioning by "Buffalo"

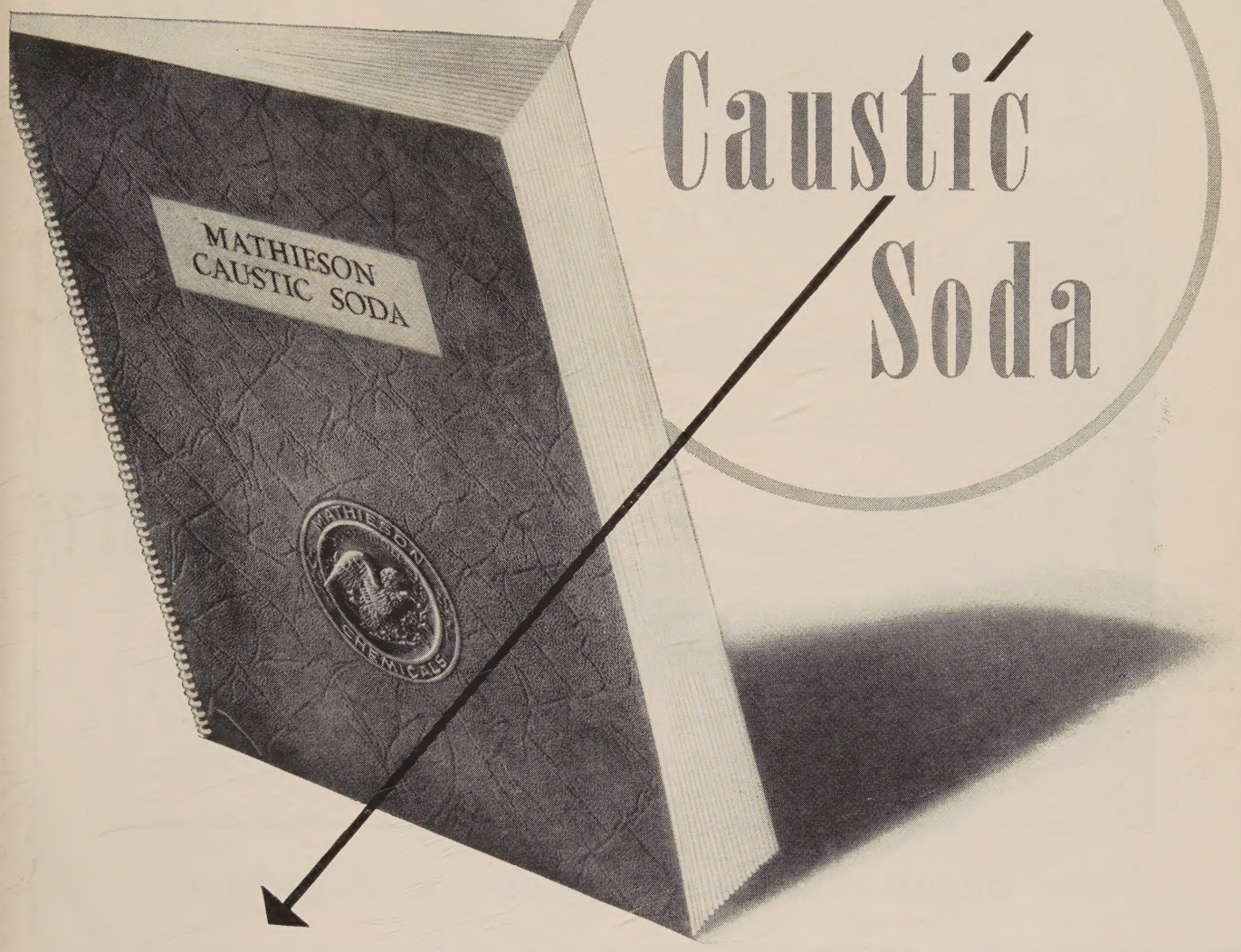
BUFFALO FORGE COMPAN

528 BROADWAY BUFFALO, N.Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Branch Offices in All Principal Cities

for users of Caustic Soda



• This completely new 48-page book entitled "Mathieson Caustic Soda" is now available to users throughout industry. Fully illustrated, it covers in detail the manufacture, economics, properties, handling and sampling of this product.

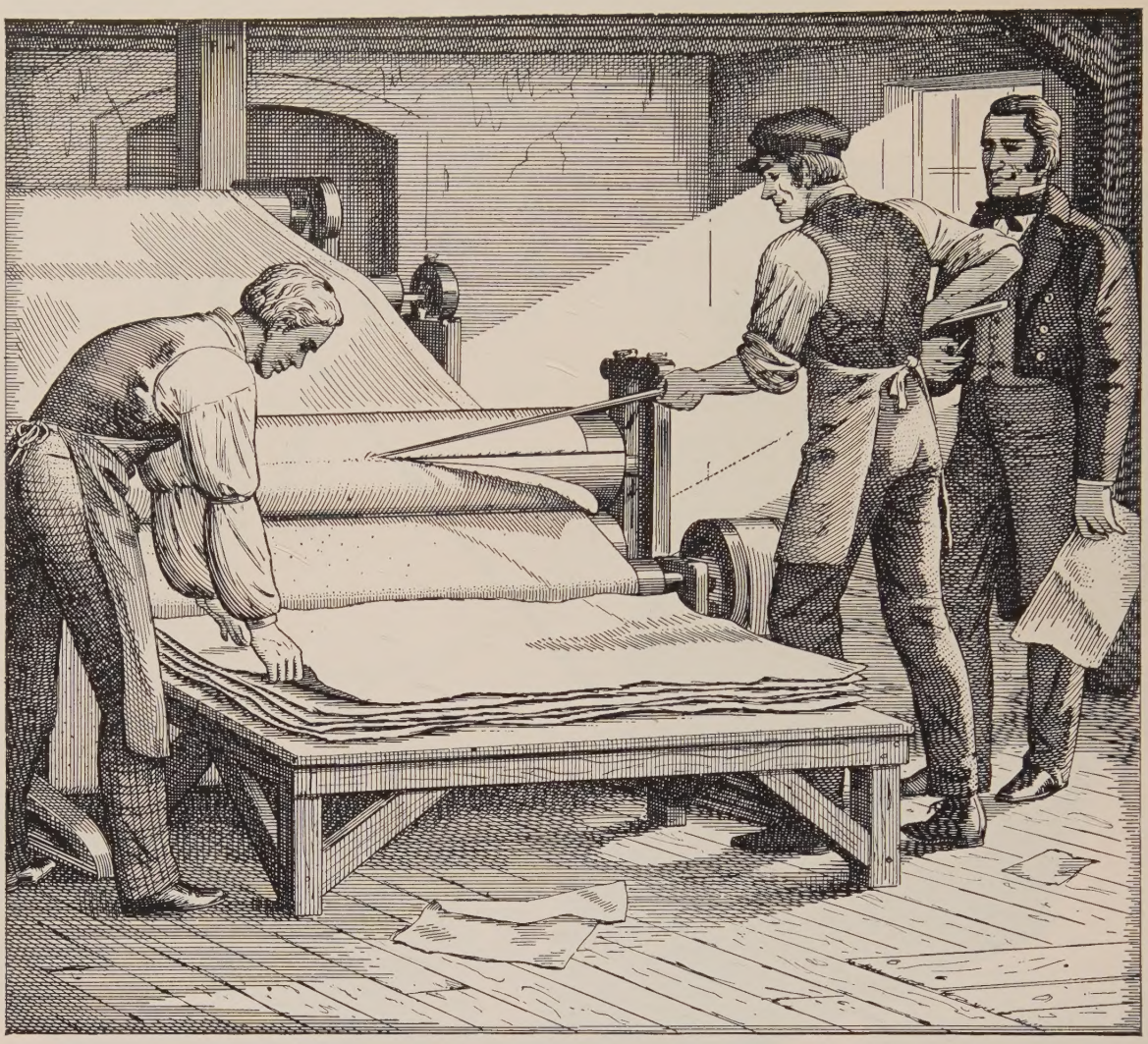
In 1923, Mathieson was the first to make regular shipments of caustic soda in liquid form. Today, because of the expanded productive capacities of its three large plants at Saltville, Va., Lake Charles, La., and Niagara Falls, N. Y., Mathieson is recognized as one of the leading suppliers of liquid caustic soda.

Users will find this new detailed book helpful in connection with the handling and application of caustic soda. Write for your copy today. Mathieson Chemical Corporation, Mathieson Building, Baltimore 3, Maryland.

Mathieson
CHEMICALS

8127

SERVING INDUSTRY, AGRICULTURE AND PUBLIC HEALTH



Here Began America's Paper-Board Industry

In 1828, G. A. Shryock, using a pulping process developed by William Magaw, began making wrapping paper from straw in his mill at Chambersburg, Pa. Soon he found that when the paper broke and several wet layers of pulp became wound around the cylinder they formed what he described as a "solid and beautiful binder's board." "Many predicted," he wrote years later, "that these boards would become one of the indispensable products of the world; others said they were not worth as much as the stones in the street."

How right were the former, how wrong the latter, history has long since proved. The boards made in this mill were not only the first successfully made from straw, but they marked the beginning of the vast and essential American paper-board industry of today.

The dramatic story of paper is told in the sound-and-color film, "Paper — Pacemaker of Progress," and in a book under the same title. Both are presented by F. C. Huyck & Sons as a tribute to the Paper Industry. The book will be sent free upon request

F. C. HUYCK & SONS • *Kenwood Mills* • RENSSELAER, N. Y.

KENWOOD WOOL PRODUCTS

HUYCK *Felts*

JOIN THE TREND

TO HIGHER QUALITY, LOWER PRICED PAPERS

Bleach your groundwood with the

DU PONT PEROXIDE BLEACHING PROCESS

AVAILABLE! IN DRUMS AND TANK CARS

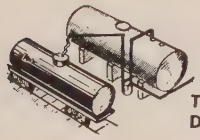
DU PONT

"ALBONE" 35 Hydrogen Peroxide 35%

"ALBONE" 50 Hydrogen Peroxide 50%

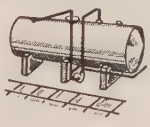
"SOLOZONE" Sodium Peroxide

FOR THE GREATEST ECONOMY CONSIDER



Tank car Deliveries

Tank Storage at the mill



If you need 5,000 lbs. or more of "Albone" Hydrogen Peroxide per month, you'll find a storage tank installation economical. Du Pont engineers will help in the planning and facilities for bulk storage and handling.

MORE AND MORE mills are turning to peroxide bleached groundwood as the answer to the demand for low priced papers which must have brightness, bulk, opacity, absorbency and good printing properties. It is particularly useful for printing papers where high strength and long life are not essential. Substantial savings in manufacturing costs can be made because you start with a low cost fiber. Through peroxide bleaching it is possible to get improved opacity in a lighter weight sheet. For the production of many kinds of paper there may be a saving of 10% to 20% in fiber cost.

Peroxide bleached groundwood is now a regular item in a substantial number of integrated and non-integrated mills. Groundwood bleaching can be easily and economically installed in practically any mill.

Peroxide bleaching is not limited to groundwood. It can be adapted to soda, sulfite, semi-chemical pulps and for waste paper recovery.

Technical service and assistance in peroxide bleaching is available from the men who pioneered the development of groundwood bleaching. For more information about Du Pont peroxides and Du Pont bleaching processes, just fill in and mail the coupon below.

DU PONT

PEROXIDES

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING...THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Dept., Wilmington 98, Delaware

Please send me further information about Du Pont peroxide bleaching processes: (check application).

_____Groundwood _____Sulfite _____Soda Pulp

_____Semi-chemical pulps _____Waste paper recovery

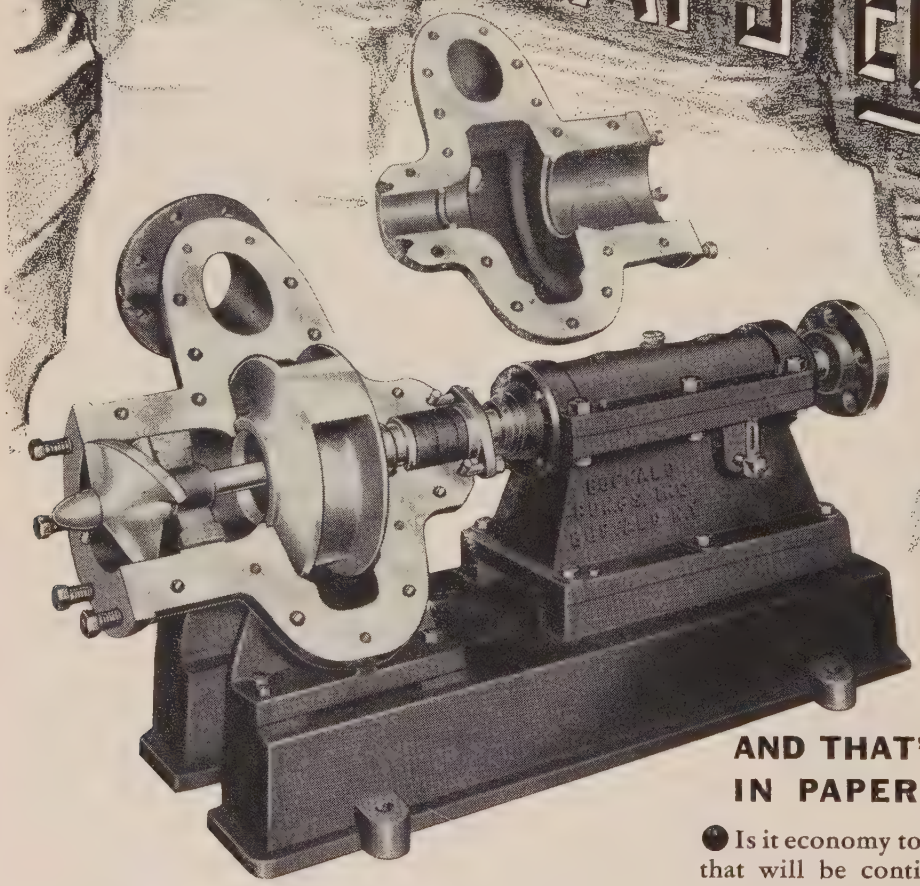
*Name*_____

*Position*_____

*Firm*_____

*Address*_____

"BUFFALO" PUMPS ENDURE!



"Buffalo" Diagonally Split-Shell Pumps like this are non-clogging, ruggedly built and have high impeller efficiencies which do NOT depend on close-running tolerances. And their diagonally split-shell construction facilitates inspection of impellers—a feature which makes them popular with maintenance men. WRITE FOR BULLETIN 953-G for the low-cost answers to any of your stock pumping problems!

AND THAT'S YOUR BIG SAVING IN PAPER STOCK PUMPING

Is it economy to install a bargain-priced pump that will be continually calling "time-out" for repairs? Costwise paper mill operators know that the pump with endurance is the economical pump! And they know the rugged, oversize, LASTING construction in "Buffalo" Non-Clogging Pumps. Why not get your pumping costs down this *fundamental* way—through *long-term* economy? Simply call your "Buffalo" engineering representative, or write:

BUFFALO PUMPS, INC.
528 BROADWAY BUFFALO, N.Y.
Canada Pumps Ltd., Kitchener, Ont.
Branch Offices in All Principal Cities

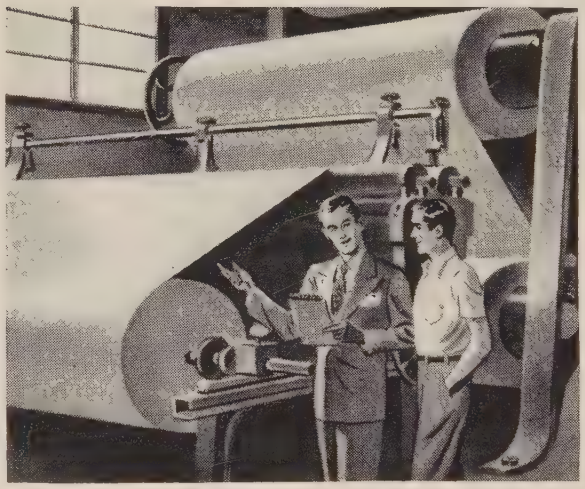
Paper Product Pointers
FROM CYANAMID

Re: Wider Markets for Paper...

Cyanamid's Technical Service Staff Helps Manufacturers Develop New Papers and Improve Quality of Their Products

Our Technical Service Staff is available to help manufacturers develop new papers through the proper application of Cyanamid chemical products. Present papers may be improved quality-wise and processes made more efficient through their experienced counsel.

If you have a "paper" problem, the services of the Technical Service Staff are at your call with no obligation. The specialized skill and experience of these paper chemical specialists, backed by our Stamford Research Laboratories, are as essential a component of our products as are the quality and uniformity inherent in every batch of Cyanamid paper chemicals.



Look us up at the TAPPI Meeting in New York in February. We will be glad to discuss your paper chemical problems with you.

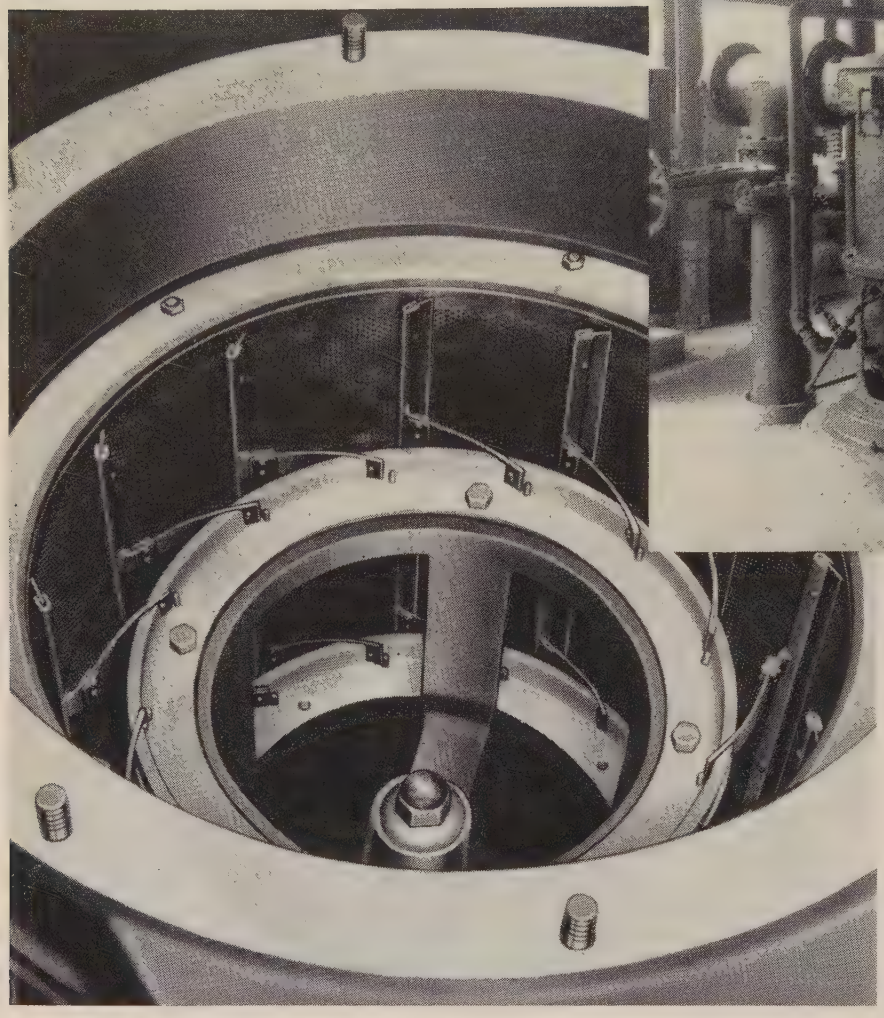
ALWAX** Sizes • WAXINE* Sizes • Rosin Size • PAREZ* Resins Synthetic Resins • Casein • Alum • Sulfonated Oils • Fillers Defoamers • Soda Ash • Caustic Soda • Salt Cake • Acids • Clays AEROSOL* Wetting Agents • CAL MICRO** (Calcium Carbonate) and other Paper Chemicals.

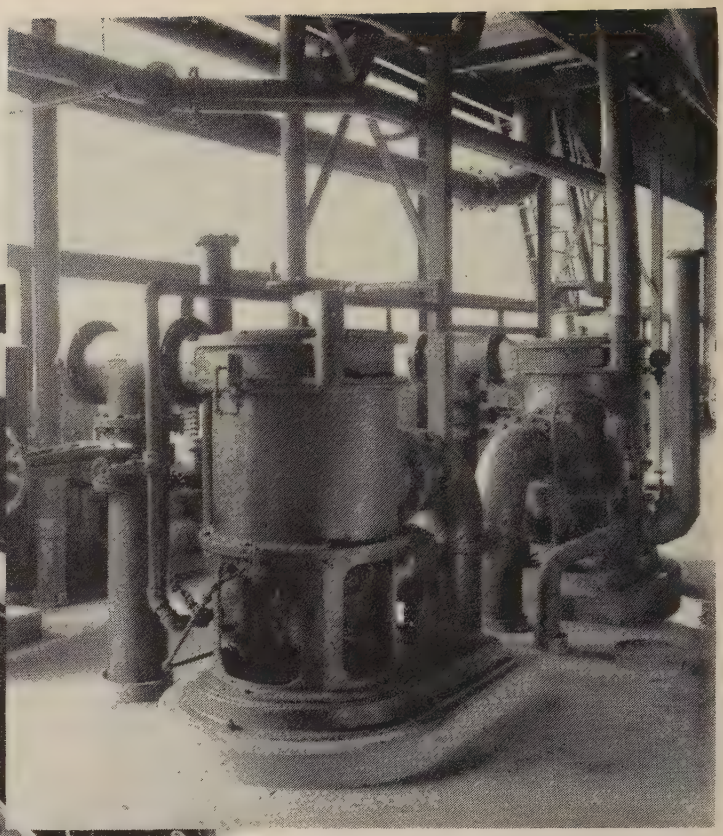
*Reg. U. S. Pat. Off. **Trade-mark

Sales Offices: Boston, Mass.; Philadelphia, Pa.; Pittsburgh, Pa.; Baltimore, Md.; Charlotte, N. C.; Cleveland, Ohio; Cincinnati, Ohio; Chicago, Ill.; Detroit, Mich.; Kalamazoo, Mich.; St. Louis, Mo.; Los Angeles, Calif.; San Francisco, Calif.; Seattle, Wash. In Canada: Dillons Chemical Co. Ltd., Montreal and Toronto.

AMERICAN Cyanamid COMPANY
INDUSTRIAL CHEMICALS DIVISION
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

NEW TYPE SCREEN





ABOVE: Two Miami Selectifier Screens serving liner vat on Black-Clawson machine at Fairfield Paper Company, Baltimore, Ohio. No mix boxes required.

REPLACING FLAT SCREENS & MIX BOXES

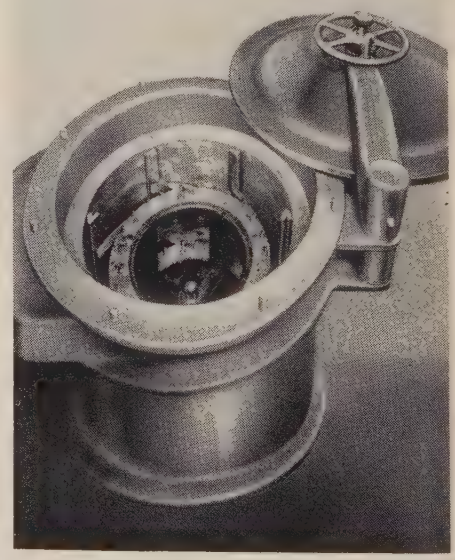
Miami Selectifier screens remove the last of the cellophane, rubber bands, pins, scale and other comparable material when used in dirty paper systems. When used on clean stock systems, filler, bond, glassine, etc., they remove fiber bundles, scale or any other foreign materials that may be present. In short, selectifier screens do a last chance and final cleaning job immediately ahead of the paper machine.

Miami Selectifier screens replace flat screens and mix boxes.

This new type screen is connected into a pipe line so the stock can travel from the pump via screen direct to the machine head box or to the vat.

Totally enclosed. Compact. Quiet. Very little power for operation. Easy to clean and very little maintenance.

How Miami Selectifier Screens operate and other data in Bulletin 100-S.



SHARTLE BROS. MACHINE CO., Middletown, Ohio

Dilts Machine Works, Fulton, New York

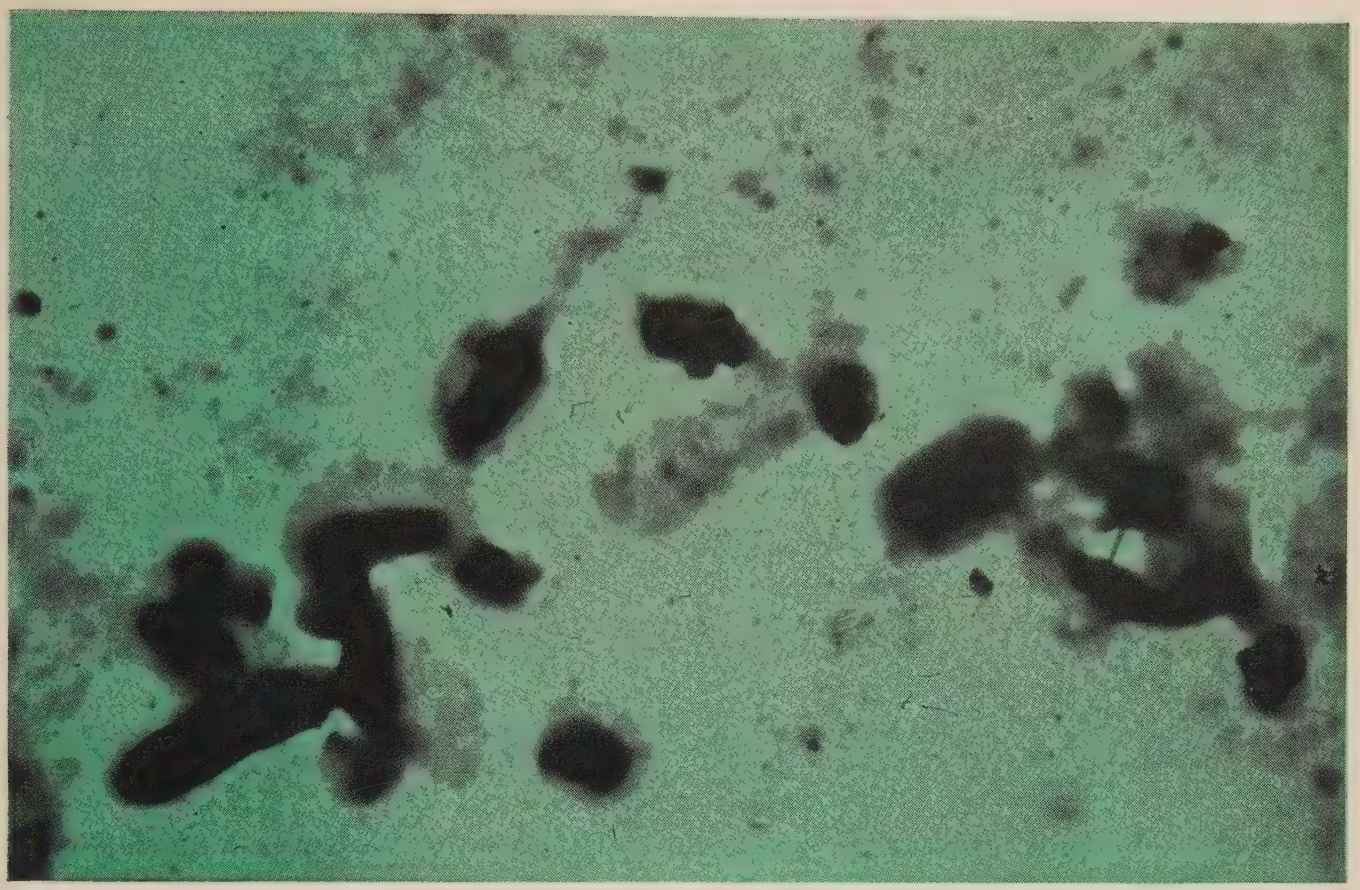
KOHLER SYSTEM EQUIPMENT • PRODUCT OF DILTS

Divisions of THE BLACK-CLAWSON COMPANY, HAMILTON, OHIO

Western Sales Office: Mayer Bldg., Portland, Oregon

Associate: Alexander Fleck Limited, Ottawa, Canada

Subsidiary: B-C International, Ltd., 16 Catherine Place, Victoria, London S.W.1, England



Bacteria Extracted from Soluble Oils Magnified 29,200X by Electron Microscope.

Deal a Blow to Bacteria!

In most any stage of production, from the raw wood to the finished product, paper and paper products are subject to attacks from bacteria and mold. These micro-organisms growing in lap stock cause discoloration and eventual loss of pulp. And through many stages of production, even to the use of adhesives in assembly, mold and bacteria are an ever-present threat.

Like many leading paper mills you can take precautions to prevent such onslaughts by providing proper microbial and mold control. Dowicides, Dow's industrial germicides and fungicides, will bring protection against these profit eaters. They will help eliminate souring and spoilage.

Deal a blow to bacteria and mold today! Investigate Dowicides. Dow maintains extensive laboratory facilities to help you solve your problems. Contact your nearest sales office or write direct.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington
Atlanta • Cleveland • Detroit • Chicago • St. Louis
Houston • San Francisco • Los Angeles • Seattle
Dow Chemical of Canada, Limited, Toronto, Canada

use the Dowicides

Industrial Germicides and Fungicides

DOW CHEMICALS
INDISPENSABLE TO INDUSTRY AND AGRICULTURE

PULP, PAPER, AND PAPERBOARD IN THE UNITED STATES*

Review for 1949

Economic Review

The year 1949 recorded the third largest annual production of paper and board in the history of the United States. Total domestic output of all types of paper and board last year was 20.3 million tons, compared with 21.9 million in 1948 and 21.1 million in 1947.

Following the comparatively lower month-to-month production in the first three quarters of 1949, there was a remarkable recovery in the last three months of the year when the industry broke all previous quarterly production records. In October, a larger output than during any calendar month in history was recorded, while production in November and December was higher than in the same months of any previous year.

It has been estimated by the Pulp and Paper Section, Office of Domestic Commerce, that actual consumption, including exports, of domestically produced paper and board in 1948 and 1949 was around 21 million tons in each year. The comparatively wide gap between production and estimated actual consumption is accounted for by a large inventory accumulation in 1948 and a using-up of excess stocks in the first six or eight months of 1949. (Refer to January, 1950, Pulp, Paper, and Board Industry Report for explanatory analysis.)

Reports from Commerce Department field offices throughout the country point out that, as of January, 1950, stocks of most grades of paper and board in the hands of wholesale merchants, converters, printers and publishers, and retail users were reasonably well balanced and in a near-to-normal relation to the level of sales. As a consequence, it is anticipated that 1950 mill production will not be influenced greatly by buying for inventory replenishment (or lack of buying for need of inventory reduction) and that output will follow closely the demands for actual consumption and for export. It is estimated that 1950 U. S. production of all grades of paper and board will be 21 million tons or more.

As the industry enters 1950 there are no substantial problems which should hinder production. In fact, sufficient capacity exists to produce upward of 23 million tons. Pulpwood supplies appear adequate to abundant in all regions, and pulp for integrated mills consequently is more or less guaranteed, while market pulp for nonintegrated mills appears to be in reasonable supply in most grades—at least, no major shortage is indicated. Waste paper in most grades continues plentiful. Chemicals and most other papermaking raw materials also appear to be available in adequate quantities. Coal is the only major uncertainty; however, no serious effects on pulp and paper mill operations have been reported to date because of the lowered production of that fuel. The outlook for 1950, especially during the first half of the year, is for maintenance of a reasonable steady level of paper and board production at firm prices. It is, however, probably too much to expect that month-to-month output in 1950 will consistently break previous monthly records established in 1948, or in the last quarter of 1949. But as long as the Nations' economy continues to expand and the population continues to increase, the long-term trend for paper and board consumption will be upward.

In 1949, the value of sales of the pulp, paper, board, and products manufacturing industry was estimated at 6.4 billion dollars, an increase of approximately 2 billion dollars, or 45% in a period of three years. In 1946, sales were 4.5 billion dollars. This sharp increase in value of sales of the industry was partly the result of a volume gain in sales of about 5% from 1946 to 1949, but more particularly to the rapid advance in prices which has occurred in virtually all commodities since the end of the war. Prices on paper, board, and products in 1949, for the most part, declined at least moderately during the first half of the year, and then firmed or increased slightly in the last quarter.

Whereas "value of sales" data serve a useful purpose in terms of measuring growth trends from year to year in a particular industry group, they do not offer a reliable basis for comparing the relative economic importance of one industry group against another. For example, the total value of sales of pulp mills added to the value of shipments of paper and board, plus the value of shipments of converted paper and board products, results in a total group industry value figure, but obviously most of the pulp was used in the production of paper and board and therefore became a part of its value, whereas a substantial part of the paper and board went into converted products like bags and boxes. Thus, there is a double or triple adding of values when the total for the industry group (pulp, paper, board, and converted products) is consolidated.

Value Added by Manufacture[a] By Major Industry Groups

Industry group	*Rank*	*Value, millions of dollars*
Food and kindred products	1	9,022
Machinery (except electrical)	2	7,817
Transportation equipment	3	5,860
Primary metal industries	4	5,775
Chemicals and allied products	5	5,360
Textile mill products	6	5,334
Fabricated metal products	7	4,918
Apparel and related products	8	4,423
Printing and publishing industries	9	4,269
Electrical machinery	10	3,894
Paper and allied products	11	2,875
Lumber and products, except furniture	12	2,513
Stone, clay, and glass products	13	2,307
Petroleum and coal products	14	2,017
Leather and leather products	15	1,485
Furniture and fixtures	16	1,379
Rubber products	17	1,303
Instruments and related products	18	1,080
Tobacco manufactures	19	643
Miscellaneous manufactures	20	2,090
Total, all industries		74,364

[a] Value added by manufacture is computed by subtracting cost of materials and supplies from value of shipments.

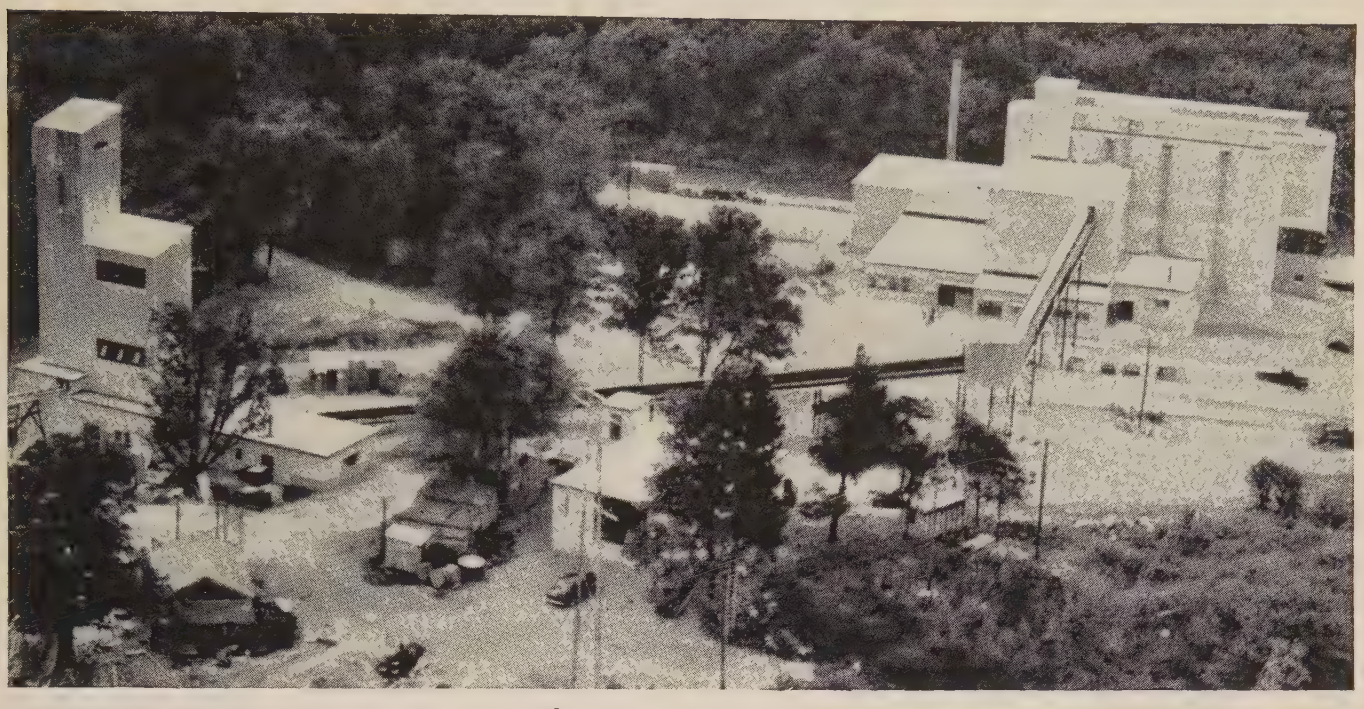
It has been found by the Bureau of the Census that a truer measure of economic relationship between industry groups is obtainable by using the "value added by manufacture" figures. The accompanying table shows that the pulp, paper, board, and products industry as a group ranks 11 among all major industry groups as classified by the Bureau of the Census for 1947.

Foreign trade in pulp, paper, board, and products is of great importance in the international trade of the United States and to the economy of the country as a whole. For many years, pulpwood, wood pulp, newsprint, and, to a lesser extent, other grades of paper, board, and products, have constituted one of the principal U. S. import groups, accounting for hundreds of millions of dollars for the use of several foreign countries, especially Canada, Sweden, Norway, and Finland, in the purchase of needed commodities or services from the United States. Exports have been of moderate significance to the industry, and while they have always been small in percentage of domestic production, have ranged well over $100 million in recent years.

The 1950 outlook for United States' exports is not encouraging, in view of devalued currencies in more than 30 foreign countries, while, on the other hand, prospects are good for a continuation of imports at or above the level of the past two or three years. When the lower tariff rates on several grades of paper and board negotiated at Annecy last year become effective, foreign producers will have an even better opportunity to enlarge sales in the United States market, especially when coupled with devalued foreign currencies.

*Prepared by W. LeRoy Neurech, Chief, Pulp and Paper Section, U. S. Dept. of Commerce, Washington, D. C.

ANOTHER VANDERBILT PRODUCT



Gouverneur Talc Co., Gouverneur, N. Y.

NYTAL

New York State Talc
for the Paper Industry
—Uniform Quality—

R. T. VANDERBILT CO. INC.
230 Park Avenue, New York 17, N. Y.

As an employer of labor (and consequently contributing to National consumer purchasing power), the industry has continued to increase steadily in importance over the past several decades. By 1949 it employed an average of 382 thousand wage earners with total wages exceeding $1111 millions. Besides, the industry contributes greatly, either directly or indirectly, to employment of labor in logging, trucking, railroad transportation, inland waterway and ocean shipping, wholesale paper distribution, and in various other fields such as the production of raw materials in the form of coal, oil, chemicals, machinery, and building materials. The industry is especially significant to the smaller towns and rural communities where practically all pulp and paper mills are located. In scores of such localities the pulp and paper mill constitutes the only mainstay of employment and resulting consumer purchasing power. Besides, each pulp mill reaches out 100 to 200 miles in all directions in purchases of pulpwood from farmers and woodland owners. Without exception, all important pulp and paper companies have purchased large areas of submarginal land and have employed foresters and local labor in the establishment of sustained yield forests, now more commonly called tree farms. This, in itself, has been of vital value to the maintenance of land productivity and long-range profitable employment of local labor.

Production Workers and Wages, Pulp, Paper, and Allied Products Industries

Year	*Average number of wage earners, thousands*	*Total dollar wages, millions*
1899	94	36
1909	145	68
1919	208	213
1929	233	287
1939	265	310
1947	391	953
1948	394	1063
1949[a]	382	1111

[a] Preliminary.
SOURCE: Bureau of Labor Statistics, Department of Labor. 1949 estimated on basis of monthly data furnished by Bureau of Labor Statistics.

In terms of physical output, the industry discloses a remarkable record, particularly since the end of World War II. To produce a total of 20.3 million tons of paper and board in 1949, the industry consumed 13.6 million tons of wood pulp, 6.6 million tons of waste paper, and 1.2 million tons of other fibrous materials. Of the total wood pulp consumed in paper and board manufacture 1.7 million tons were imported.

Pulp, Paper, and Board Industry High Lights

Item	*Unit, millions of*	*Year* 1949	1948	1947	1939
Pulpwood consumption	Cords	19.9	22.3	20.6	10.8
Wood pulp production	Tons	12.1	12.9	11.9	7.0
Wood pulp consumption[a]	Tons	13.6	14.3	13.2	8.7
Waste paper consumption	Tons	6.6	7.6	8.0	4.4
Paper and board production	Tons	20.3	21.9	21.1	13.5
Wood pulp imports[b]	Tons	1.8	2.2	2.3	2.0
Newsprint imports	Tons	4.6	4.4	4.0	2.6

[a] In manufacture of paper and board only.
[b] Includes rayon and other nonpaper grade pulp.
SOURCE: Bureau of the Census, U. S. Department of Commerce.

The domestic wood pulp industry produced in 1949 12.1 million tons of pulp which required 19.9 million cords of pulpwood. Of total domestic pulp output, the bulk went to United States paper and board manufacturers and to nonpaper producers such as rayon and plastics, with only 96 thousand tons being exported. Total wood pulp imports in 1949 were about 1.8 million tons of which Canada supplied 1.3 million tons, Sweden 385 thousand tons, and Finland 176 thousand tons, with the balance from other countries.

On the import side, in addition to wood pulp, the United States imported 1.7 million cords of pulpwood and 4.6 million tons of newsprint, principally from Canada. Imports of other grades of paper, board, and products amounted to about 37 thousand tons. On the export side, besides pulp, the United States shipped to various foreign countries in 1949 about 181 thousand tons of paper and board and 77 thousand tons of paper products. It is obvious that either in terms of value or quantity, imports of the industry range many times greater than exports.

The value of sales of wholesale paper distributors from 1939 to 1949 did not increase percentagewise as much as the value of manufacturers' sales. On a value basis, wholesale sales in 1949 show an increase of 150% over 1939; manufacturers' gained 258%. This comparison reflects the large gains made in the use of boards for boxes, the big increases in the use of paper by large printers and publishers, and in other fields where paper or board does not flow through the wholesale distributor.

Annual Value of Sales of United States Wholesale Distributors of Paper and Its Products: 1939–1940

Year	*Millions of dollars*	*Year*	*Millions of dollars*
1939	575	1945	866
1940	595	1946	1338
1941	750	1947	1625
1942	752	1948	1575
1943	801	1949[a]	1437
1944	835		

Monthly Value of Sales of United States Wholesale Distributors of Paper and Its Products: 1946–1949

Month	*Millions of dollars* 1946	1947	1948	1949
January	90	134	139	121
February	81	118	128	111
March	94	125	134	122
April	101	132	131	115
May	112	130	123	109
June	113	134	132	116
July	112	128	117	105
August	125	130	134	128
September	128	153	137	127
October	140	165	139	129
November	125	137	134	130
December	117	139	127[a]	124
Total	1335	1625	1575	1437

[a] Preliminary.
SOURCE: Prepared by Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce, from data supplied by Business Structure Division, U. S. Department of Commerce.

*Raw Materials**

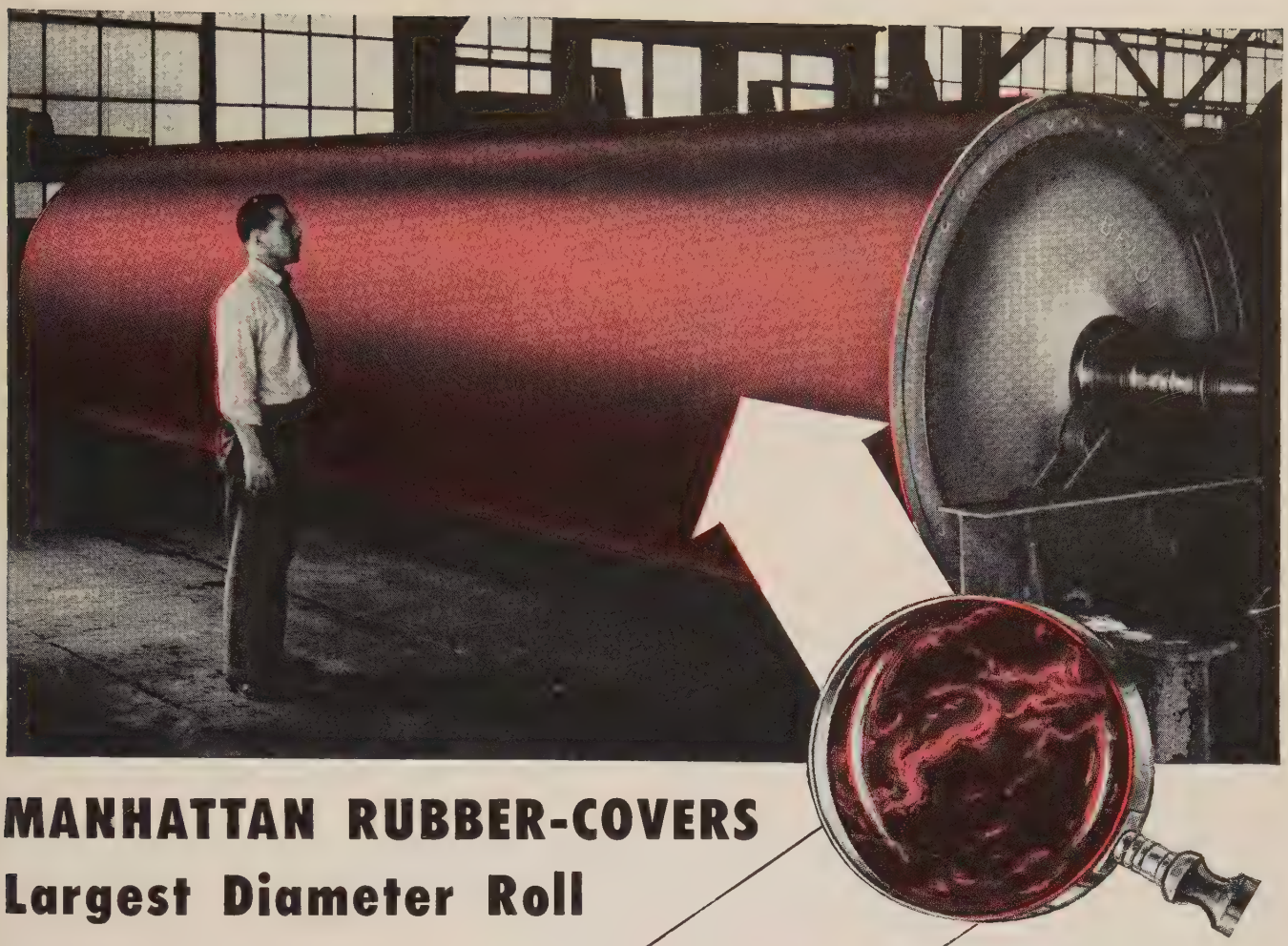
Pulpwood

Nearly 20 million cords of pulpwood were consumed by domestic wood pulp mills during 1949 in preparing the basic material for the manufacture of paper, board, and, in a lesser degree, rayon and other nonpaper items. Although this total was more than 10% below that of 1948, it nevertheless represented a volume which would have been considered difficult of attainment only a few years ago.

At the beginning of 1949, pulpwood procurement was on a scale generally adequate to the continuing high level of pulp and paper production. Woods labor was plentiful and relations between workers and management generally harmonious. Equipment was sufficient for full-scale operations, as was the supply of railroad freight cars. The over-all stocks of pulpwood in the hands of mills ranged from ample to superabundant. As a result, pulpwood prices continued to exhibit the easy trend which had characterized the market throughout the latter part of 1948.

Mill inventories at the start of 1949 were well over 5.5 million cords, a condition of abundance which caused a slowdown in logging operations to a point of virtual standstill in many parts of the country. Woods activities in respect to pulpwood gathering were on a drastically reduced scale throughout the spring and summer, when cutting was reportedly 25% below the 1948 rate in some areas. Not only was the logging activity strictly curtailed on most company-controlled timber lands, but mill purchases of wood from farmers and other small wood-lot owners also were kept to a minimum. Most mills, in fact, withheld their purchases, pending consumption of current stocks of relatively high-cost wood.

* Sections on Raw Materials prepared by WALKER J. MYERS.



MANHATTAN RUBBER-COVERS Largest Diameter Roll

Rub-Roc Surface Improves Kraft Quality

The man is dwarfed by the size of this huge Dual Press Center Roll. Overall dimensions are 60″ x 268¼″. Its five-foot diameter makes it one of the largest diameter rolls ever rubber covered. It is rubber covered with Manhattan's exclusive Rub-Roc surface, ½″ thick over a face length of 220″—nearly 18½ feet.

The southern paper mill where this roll is installed makes kraft and other specialties. The finely mottled surface of Rub-Roc shown magnified to actual size contributes to the top quality of the products of this mill. Rub-Roc surface is designed to hold water and release the paper instantly so that paper does not stick or crush and felts wear longer. Rub-Roc is a dense, hard surface that does not pick-up or crack. It helps produce a uniform quality and finish.

Two points stand out in this new Manhattan "Largest". First, you can depend upon Manhattan for the technology of rubber covering for your individual mill requirements. Second, you can rely on Manhattan manufacturing capacity to handle jobs of any size.

We have rubber covered many of the world's largest rolls in the past and our facilities are always up-to-date to meet new challenges of size or engineering. If you are not already acquainted with a Manhattan Roll Covering Engineer, be sure to call one on your next roll problem.

ROLL COVERING PLANTS AT PASSAIC, N. J. . . . NEENAH, WISCONSIN . . . NORTH CHARLESTON, S. C.

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RM

RAYBESTOS-MANHATTAN, INC.

Manufacturers of Mechanical Rubber Products • Rubber Covered Equipment • Radiator Hose • Fan Belts • Brake Linings • Brake Blocks • Clutch Facings • Packings • Asbestos Textiles • Powdered Metal Products • Abrasive & Diamond Wheels • Bowling Balls

Pulpwood—United States Annual Receipts, Imports, Consumption, and Inventories

(1000 Standard Cords—Roughwood Basis)

	1949[a]	1948	1947	1946	1945	1944	1943	1942	1941
Receipts									
United States, total	19,252	22,333	20,619	18,978	16,983	16,998	15,293	17,140	16,458
Domestic	17,547	20,026	18,543	16,980	15,254	15,349	13,581	14,908	14,177
Imported	1,706	2,307	2,076	1,997	1,729	1,650	1,712	2,232	2,281
Northeast, total	3,325	4,039	4,135	3,650	3,389	3,039	2,954	3,399	3,486
Domestic	2,321	2,666	2,970	2,508	2,311	1,976	1,906	2,238	2,252
Imported	1,001	1,373	1,165	1,142	1,078	1,063	1,047	1,161	1,235
Appalachian, total	1,548	1,784	1,623	1,716	1,388	1,482	1,303	1,475	1,412
Domestic	1,548	1,763	1,610	1,684	1,365	1,472	1,302	1,448	1,378
Imported	..	21	13	32	23	10	2	27	34
South, total	9,057	9,997	8,227	7,909	7,153	7,090	6,505	6,622	6,400
Domestic	9,057	9,997	8,227	7,909	7,153	7,090	6,505	6,622	6,400
Imported	..	..	..	..	..	..	..	..	..
Lake States, total	2,160	3,031	2,900	2,919	2,456	2,637	1,969	2,796	2,241
Domestic	1,609	2,344	2,154	2,239	1,954	2,175	1,409	1,983	1,561
Imported	552	687	746	680	502	463	560	813	680
Pacific Northwest, total[b]	3,162	3,482	3,734	2,784	2,596	2,750	2,561	2,948	2,918
Domestic	3,015	3,256	3,581	2,642	2,470	2,636	2,458	2,616	2,585
Imported	148	226	153	142	126	114	103	231	332
Consumption, total[c]	19,916	21,189	19,714	17,818	16,912	16,754	15,645	17,275	16,580
Northeast	3,395	3,814	3,740	3,466	3,245	3,159	3,265	3,530	3,515
Appalachian	1,614	1,767	1,684	1,501	1,444	1,490	1,442	1,498	1,420
South	2,459	9,443	8,395	7,516	7,208	7,153	6,342	6,804	6,227
Lake States	9,251	2,821	2,724	2,554	2,544	2,474	2,325	2,471	2,398
Pacific Northwest[b]	3,199	3,344	3,171	2,781	2,472	2,482	2,271	2,972	3,019
Inventories, total[d]	4,877	5,622	4,566	3,780	2,627	2,819	2,846	3,392	3,729
Northeast	1,526	1,644	1,442	1,063	869	700	820	1,119	1,218
Appalachian	335	397	372	422	206	279	280	423	439
South	1,315	828	291	526	145	218	293	126	334
Lake States	670	1,674	1,486	1,350	986	1,088	962	1,313	995
Pacific Northwest[b]	1,031	1,079	974	419	420	534	491	410	742

[a] Preliminary.
[b] Converted 600 board feet equal 1 cord.
[c] Total consumption for 1940 was 13,743,000 cords; for 1939 it was 10,816,000 cords.
[d] End of year.
Note: Detail may not add to totals because of rounding.
SOURCES: Prepared by Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce; data covering 1939, 1940, 1945, 1946, 1947, and 1948 from Bureau of the Census, U. S. Department of Commerce; data covering 1941–1944, inclusive from Forest Products Bureau, War Production Board.

Logging operations, apart from some fall revival of activity on the part of certain large mills in the Pacific Northwest, continued at a subnormal tempo throughout the remainder of the year. Even these Northwestern activities—inclusive of limited wood buying—were selective in character, inasmuch as hemlock, the principal pulping species of the district, was in surplus as the result of heavy imports from British Columbia. Some regional pickup in pulpwood logging was noticeable during the first weeks of 1950, though in less than seasonal volume, and wood purchases were generally limited to conservative totals despite the stronger demand for pulp. Woods operations are generally expected to attain normal volume during the latter part of the first quarter.

The diminishing curve of pulpwood procurement in 1949 was well reflected in the lowering levels of national wood stocks at pulp mills during the year. The national wood pile, after increasing its total by more than a million cords during the latter half of 1948, maintained itself at near-top level during the first two months of 1949. Thereafter, aggregate wood stocks dropped to a low of around 4.9 million cords in June and finished the year at approximately that level.

Notwithstanding the over-all decline, regional stocks of pulpwood did not reveal strictly uniform trends during the year. Inventories in the Northeast and the Pacific Northwest, for example, increased consistently from the early summer. The Lake States region, on the other hand, decreased its stocks half a million cords during the several months ending with October. The South, where pulpwood stocks are customarily at a relatively low level because of virtually year-round procurement and the inadvisability of prolonged wood storage, had declining stocks of pulpwood throughout the year. Despite the general reduction of wood stocks, no appreciable shortages at pulp mills were reported during the year.

Prices of pulpwood, though subject to the vicissitudes of regional conditions and logging techniques, were for the most part increasingly easy in tone during 1949. By mid-summer, pulpwood prices in the Great Lakes area were reportedly down several dollars a cord, while those in the South had declined from $1.00 to $1.50. In the Pacific Northwest, where pulpwood is a concomitant of the lumber industry, the consistent production of pulping species logs, along with those of sawmill specifications which were in active demand, made for comparatively cheap pulp logs.

In the fall of 1949, pulpwood prices, with some localized exceptions, were on a somewhat more stable basis. Although some new contracts, toward the year's end, were negotiated at price reductions of around 5%, there was a fairly widespread firming of prices. Trade reports attributed this renewed steadiness of pulpwood price levels to several factors: the revived demand for pulp during the latter part of 1949; the lack of snow in the Northeastern United States and Eastern Canada, retarding the movement of pulpwood from the woods to the streams, and hence, to the mills; and the resumption of wood buying by pulp mills at a more or less normal rate.

Woods labor at the end of 1949 was ample, as it had been throughout the year. Mechanization of logging functions was stimulated in the Northwest by increasing logging costs and no serious shortage of equipment developed in any section of the country. In the Northwest, too, the expansion program in the pulpwood field includes the installation of hydraulic barkers, whole-log chippers, and a rather extensive use of logging debris and sawmill waste.

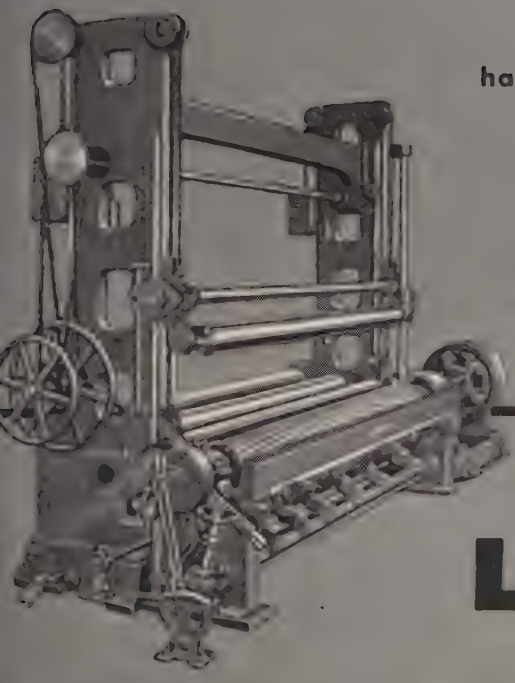
United States requirements of pulpwood, though depending preponderantly on domestic supplies, looks to Canada for 10% of total needs. Continuing a policy adopted in World War II, Canada has established an annual quota of pulpwood for export to the United States. In 1949, an initial quota of 1.35 million cords was later increased to 2 million cords and supplemented by 100,000 cords of fire-killed timber. This quota proved exceedingly liberal, inasmuch as 1949 pulpwood imports from Canada totaled only 1.7 million cords, or nearly 25% less than in 1948. Prices of imported pulpwood, approximately 90% of which was softwood, declined during most of 1949 in the same general degree as prices for domestic pulpwood.

Discussions of international pulpwood matters at the FAO meeting in Montreal in the spring of 1949 brought out the opinion that, in North America, accessible forest resources were capable of maintaining pulpwood supplies adequate for current production levels. Sufficient wood supplies for greatly expanded pulp production, however, must (according to the consensus at the Con-

long or short KEN?

The Siamese Ken equals 40 inches,
while in Japan it means 80% more for your
money. Langston Slitters and Roll Winders
have long been noted for extra values—
no matter what the basis of measurement.

Samuel M. Langston Company,
Camden, New Jersey.



SLITTERS

Langston

ROLL WINDERS

Wood Pulp—United States Annual Imports and Exports: 1940–1949

(1000 Short Tons)

Item	1949[a]	1948	1947	1946	1945	1944	1943	1942	1940
Imports, total	1761	2176	2295	1795	1752	1072	1306	1237	1225
Bleached sulphite: rayon and special chemical grades	154	244	248	202	144	131	129	134	114
Bleached sulphite: other	331	317	289	223	242	189	231	241	239
Unbleached sulphite	392	673	731	619	657	399	519	459	373
Bleached sulphate	392	278	239	80	72	47	48	58	85
Unbleached sulphate	248	336	468	398	380	99	105	91	224
Soda	27	25	21	20	21	16	20	18	11
Chemical screenings	3	8	10	9	7	7	11	8	8
Bleached mechanical	1	..	..	1	1	[b]	..	..	..
Unbleached mechanical	208	290	286	238	222	177	236	220	171
Mechanical screenings	6	5	5	6	5	5	6	7	[b]
Exports, total	123	93	130	39	136	218	301	378	481
Bleached sulphite: rayon and special chemical grades	25	16	11	8	13	11	23	29	115
Bleached sulphite: other	20	15	44	7	17	38	45	78	102
Unbleached sulphite	39	53	54	17	27	46	90	98	72
Bleached sulphate	10	1	2	1	6	7	16	28	18
Unbleached sulphate	27	6	17	5	60	106	121	140	159
Soda	[b]	1	1	[b]	11	11	5	3	10
Screenings and other wood pulp	[b]	1	2	1	2	[b]	1	1	4

[a] Preliminary.
[b] Less than 500 tons.
Note: Detail may not add to totals because of rounding.
SOURCE: Prepared by Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce, based upon data from the Forest Products Branch, Office of International Trade, and the Bureau of the Census, U. S. Department of Commerce.

ference) be predicated upon: (1) application of improved forest management to many additional forest areas; (2) development of more adequate protection against fire, insects, and disease; utilization of greater quantities of hardwood and wood waste, and improvement of high-yield pulping methods. It was pointed out at the Conference that there were large forest areas, not fully utilized, in the northern part of Canada, Alaska, and in portions of the Rocky Mountains area.

Reference to the last-named region has meanwhile been substantiated by the United States Forest Service in offering for sale 4½ million cords of pulpwood in the national forests of western Colorado. The Forest Service estimates that the available wood—consisting predominantly of insect-killed Engelmann spruce and other species—is sufficient to supply a pulp mill of 60,000 tons or more annual capacity for the 30-year period covered by the sales contract.

Despite the persistent efforts of research agencies to adapt and improve pulping methods to afford a larger utilization of hardwoods, the quantity of hardwoods consumed in 1949 (13% of the total) represented about the same percentage of total wood-conversion as in the two preceding years. It is confidently anticipated, however, that hardwood species will play an increasingly important role, not only in paper and board manufacture but also in the production of rayon and other nonpaper products. Experimentation toward that end has proceeded, not only in respect to the chemical pulping processes, but also to the mechanical. While poplar is the most extensively used hardwood for pulping, many other varieties have been tested as suitable materials for the production of container board, newsprint, and many other paper grades. A new mill using poplar predominantly in the manufacture of semichemical pulp began operations in the Lake States in 1949. Two new mills for the utilization of hardwoods in the output of dissolving pulp are currently projected for the Southern United States.

The foregoing exemplifies, in part, the adaptation of a growing pulp and paper industry to a changing pattern of raw material supplies—in this instance, a progressive shrinkage of economically accessible softwoods. Potential limitations of imported wood, resulting from Canadian conservation policies, also emphasize the need for more intensive and complete usage of available domestic supplies. Possible need of North American pulpwood for foreign pulp production is suggested by 1949 inquiries from Japan, who was a large prewar buyer of United States saw logs and "Jap squares."

Conditions generally at the start of 1950 are favorable for pulpwood procurement in an adequate volume throughout the current year, barring unforeseen eventualities. Mill inventories of wood, in fact, are at a higher level than at the beginning of any previous year, excepting 1948. Labor, equipment, and most of the other factors necessary for satisfactory wood accumulation, are present in ample quantities. No serious discrepancy in the anticipated balance between supply and demand is noted in any important pulpwood consuming region.

Wood Pulp

Domestic production of wood pulp during the year 1949, after sinking to a three and one-half years' low monthly total of 800,000 tons in July, rebounded with characteristic resilience. Climbing vigorously through August and September in response to a strong, revived demand for paper and board, pulp output reached a national total in October not achieved in any of the 12 previous months. Though holidays caused a seasonal slackening in November and December, tonnages for those two months, for the first time since February, 1949, were at higher levels than in the corresponding months of 1948. Production for the full year 1949 reached a grand total which only once before had been equaled by the domestic pulp industry—and that in the preceding year.

Pulp production in 1949 began on a note of quiet confidence despite a growing modification of demand, a general adequacy of supplies, and a consequent softening of prices to levels considered to be more consistent with the supply-demand position than had been the case previously. During the first two months, production figures were above those of previous years, despite some cutbacks in the unbleached chemical grades which presaged declines in these categories later in the year. The supply of the bleached grades started the year neck and neck with demand and remained in a fairly tight market position throughout the year. By April, over-all pulp production had fallen well under corresponding 1948 monthly totals in a drastic decline which persisted until August witnessed the sharp reversal of trend mentioned above.

Wood pulp for the most part continued in adequate supply through the early summer of 1949, with consuming mills experiencing periodic difficulty only in obtaining prompt delivery of the bleached grades, both sulphite and kraft. Other pulp categories, especially in the unbleached classes, were periodically in surplus around the middle of the year, with considerable tonnages of spot pulp at times overhanging the market. These conditions of superabundance in the extensively used unbleached grades, together with narrow bidding for the bleached grades, combined to create a slow pulp market. Moreover, the summer gearing of paper and board production schedules to current restricted orders and the uncertainties surrounding paper and board price trends led to an unwillingness on the part of consuming mills to purchase pulp in excess of their immediate requirements. General withdrawals from inventory by June 30 had brought over-all pulp stocks down 20% below the position at the year's start. National pulp production for the first half of 1949 was 7% below the like period of 1948 with bleached kraft the only major grade to register a gain, and unbleached sulphite suffering the greatest proportionate decline.

The upswing in paper and board output, following the lull oc-

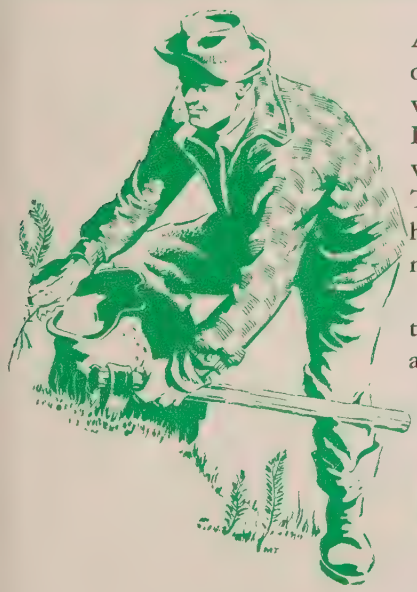
...this is Tree Farming

Seed Blocks Restock Cutover Land

Hand Planting on Burnt-Over Areas

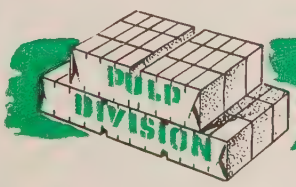
Young Second Growth on a Tree Farm

Spotter Plotting a Fire Location



A forest is not like an oil well or a mine... consisting only of a given amount of irreplaceable material. Forests are *living things*... and given a fair chance will reproduce themselves, barring complete destruction of the seed source. In fact, for years it has been a Weyerhaeuser tenet that . . . "Man cooperating with nature can provide a new forest as good or better than the original." To further implement this basic concept of forest management, Weyerhaeuser has joined others in the forest industry in establishing over two million acres of certified tree farms in Oregon and Washington.

The Pulp Division, Weyerhaeuser Timber Company, will benefit from this enlightened cooperative forest management program through a guaranteed source of supply for its sulphite and sulphate pulp mills.



WEYERHAEUSER

Wood Pulp—United States Annual Production and Domestic Consumption: 1939–1949

(1000 Short Tons)

Item	1949[a]	1948	1947	1946	1945	1944	1943	1942	1941	1939
Production, total	12,137	12,872	11,946	10,607	10,167	10,108	9,680	10,783	10,375	6993
Sulphite, total	2,537	2,811	2,796	2,476	2,360	2,386	2,437	2,930	2,919	1946
Bleached	1,827	1,909	1,902	1,692	1,544	1,523	1,553	1,717	1,703	1217
Unbleached	710	902	894	784	816	863	883	1,213	1,216	729
Sulphate, total	5,969	6,014	5,357	4,588	4,472	4,549	4,236	4,738	4,527	2963
Bleached	1,122	1,040	909	750	705	665	602	653	659	424
Semibleached	261	225	193	152	149	144	147	159	164	[b]
Unbleached	4,585	4,749	4,255	3,686	3,618	3,740	3,487	3,927	3,704	2538
Soda	492	510	492	476	430	413	419	462	480	1442
Groundwood	1,962	2,175	2,050	1,897	1,696	1,639	1,638	1,756	2,152	1445
Defibrated, exploded, etc.					691	663	627	520	365	[c]
Semichemical	1,178	1,362	1,252	1,169	519	459	324	377	298	198[c]
Screenings, damaged, etc.										
Consumption, total	13,608	14,347	13,252	12,092	10,825	10,502	10,635	11,038	11,364	8650
Sulphite, total	3,017	3,334	3,229	3,144	2,583	2,519	2,892	3,079	3,348	2913
Bleached	1,848	1,856	1,792	1,680	1,346	1,277	1,442	1,498	1,805	[b]
Unbleached	1,169	1,478	1,437	1,465	1,237	1,242	1,449	1,581	1,543	[b]
Sulphate, total	6,676	6,663	5,860	5,141	4,680	4,588	4,430	4,633	4,614	3354
Bleached	1,493	1,305	1,068	833	756	714	683	667	696	[b]
Semibleached	273	251	199	184	168	156	163	164	208	[b]
Unbleached	4,910	5,107	4,594	4,124	3,756	3,719	3,584	3,802	3,710	[b]
Soda	525	521	520	492	440	418	456	469	515	516
Groundwood	2,207	2,448	2,328	2,133	1,905	1,830	1,855	1,926	2,219	1749[c]
Defibrated, exploded, etc.		746			684	661	639	527	346	[c]
Semichemical	1,182	149	1,315	1,181	533	486	364	404	321	119[c]
Screenings, damaged, etc.		485								

[a] Preliminary.
[b] Not available.
[c] Data on "defibrated, etc," included in "groundwood" and "semichemical, off quality, screenings and miscellaneous."
Note: Detail may not add to totals because of rounding.
SOURCE: Prepared by Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce, based upon data from Bureau of the Census, U. S. Department of Commerce.

casioned by the July holidays, was immediately reflected in rising pulp production which staged a spectacular and steady ascent from the July low to the year's high mark in October. The tone of the pulp market during the late summer was one of general improvement and increased activity, despite the fact that mills continued to dip into inventories well into October. Demand for pulp was generally strong throughout the fall season and for the remainder of the year. Requirements for the unbleached grades, though steady, were relatively less insistent than for the bleached categories, especially those for bleached sulphate. This latter grade, over and above its traditional use in the manufacture of book, fine and wrapping papers, and folding boxboard, has developed increasing outlets as a substitute for bleached sulphite, and in products such as waxing stock for frozen food packs, meat and bread wrappers, twisting and spinning papers, and numerous others.

Domestic consumption of wood pulp in paper and board manufacture during 1949 was slightly over 13.6 million short tons which next to 1948, represented the second highest annual use of this basic raw material. Of the total, approximately 17% of the pulp consumed was market, or purchased pulp, used chiefly by paper and board mills whose operations are not integrated—or integrated only in part—with their wood pulp supplies. Although these nonintegrated mills use only a small portion, quantitatively, of pulp totals, their significance from the standpoint of over-all paper and board supply lies in the fact that their output represents substantial portions of specialty items, in contrast with the general tendency of integrated mills to concentrate on mass production grades. In consequence, the nonintegrated mills which manufacture items requiring more exacting and comparatively more rigid processing techniques, experienced difficulty during 1949 in adapting their operations and in reducing their prices to meet the more intensive competitive pressure engendered by lower market price levels and a limited and more selective demand.

Supplies of market pulp, at the start of 1949, were ample in most grades, with surpluses evident in some classes. A reduction in the operating schedules of the nonintegrated mills early in the year accentuated the easy tone of the market. These reduced operations resulted from the nonintegrated mills having experienced greater loss in their paper sales than their competitors in the integrated field. Another factor contributing to the plenitude of pulp in the spring of 1949 was the increased availability of pulp offered by integrated mills whose sales of paper, at that time, had not kept pace with their pulp capacity.

Relative decline in the paper and board production of pulp-purchasing mills was apparent in the drop of 19% in the consumption of market wood pulp (as against a decline of only 8½% in over-all consumption), during the first half of 1949 as compared with the same period of the preceding year. Market pulp consumption followed an almost uninterrupted downward pattern during the first seven months of the past year, and turned upward in August to reach top levels of pulp use near the year's close. Inventories of market pulp were dipped into consistently after July, 1948. From a high mark of 588,000 tons at the end of that month, nationwide stocks of market pulp shrank steadily to a low of less than 300,000 tons in October, 1949—a total appreciably below levels characterized by a leading trade executive as "dan-

Total United States Annual Wood Pulp Imports, All Grades—By Major Countries of Origin

(1000 Short Tons)

Country	1939	1940	1941	1945	1946	1947[a]	1948[b]	1949
Total	2026	1225	1158	1754	1795	2295	2176	1761
Canada[c]	638	828	1145	1082	1234	1505[d]	1601[e]	1314
Sweden	873	279	..	672	445	556	385	268
Finland	337	93	13	..	115	220	176	141
Norway	96	17	..	..	..	10	13	34
All other	82	8	..	..	..	5[f]	2[g]	4[h]

[a] Revised.
[b] Preliminary.
[c] Includes Newfoundland.
[d] Newfoundland 7854 tons.
[e] Newfoundland—7137 tons.
[f] U.S.S.R.–4928 tons.
[g] All from Austria.
[h] Austria—3194; Czechoslovakia—973.
Note: Detail may not add to totals because of rounding.
SOURCE: Prepared by Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce, based upon data from the Forest Products Branch, Office of International Trade, and the Bureau of the Census, U. S. Department of Commerce.

THE FUTURE OF YOUR PRODUCT IS IN THESE HANDS

wet-strengthen your paper with the UFORMITES

A million hands test your product—the hands of your customers' customers, who demand *wet strength* in paper.

To satisfy these ultimate users—and their suppliers—wet-strengthen your paper with the UFORMITES, quickly, easily at low cost. As little as $4 per ton of paper boosts wet Mullen values 300%, raises dry Mullen and fold values 10% to 30%, and increases wet rub and scuff resistance, and wet and dry tensile. No pretreatment, special equipment or special processing is necessary.

Full technical information on the UFORMITES is yours for the asking.

OTHER CHEMICALS FOR THE PAPER INDUSTRY

RHOZYMES BB and E-5—for enzyme conversion of starch.

TAMOL N—for effective pitch control—a dispersing agent for pigments.

TRITONS—Surface-active agents with a score of uses in paper manufacture—in caustic cooking of cotton fiber, as a dispersing agent for pigments and metallic soaps, emulsion-type coatings.

The Hydrosulfites—Reducing agents for stripping color from rag stock or for bleaching pulp.

HYAMINES—Deodorants for paperboard and glue bactericides.

UFORMITE, RHOZYME, TAMOL, TRITON, HYAMINE *are trademarks, Reg. U.S. Pat. Off. and in principal foreign countries.*

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square Philadelphia 5, Pa.

The Resinous Products Division was formerly The Resinous Products & Chemical Company

Market Wood Pulp[a]—Paper and Paperboard Mills Only—Annual Receipts, Consumption, and Inventories: 1947–1949

(1000 Short Tons)

Item	1949	1948	1947
Wood pulp, total all grades			
Receipts, total	2183	2448	2709
Domestic	947	1058	1189
Imported	1238	1489	1520
Canada, and Newfoundland	730	901	784
European	510	589	736
Consumption (purchased pulp), total	2359	2564	2511
Inventories (purchased pulp), total[c]	343	519	532
Domestic shipments, total[d]	929	1014	1041
Sulphite, all grades			
Receipts, total	1207	1471	1552
Domestic	588	647	722
Imported	617	824	831
Canada and Newfoundland	370	524	492
European	246	299	341
Consumption, total	1312	1453	1431
Inventories, total[c]	193	297	283
Domestic shipments[d]	597	641	654
Sulphate, all grades			
Receipts, total	621	714	779
Domestic	191	200	260
Imported	432	515	522
Canada and Newfoundland	204	237	154
European	228	279	367
Consumption, total	674	720	729
Inventories, total[c]	103	158	188
Domestic shipments[d]	183	189	199
Groundwood and other grades			
Receipts, total	357	362	375
Domestic	169	213	207
Imported	188	149	175
Canada and Newfoundland	154	137	138
European	38	10	30
Consumption, total	373	392	349
Inventories, total[c]	46	65	61
Domestic shipments[d]	153	183	186

[a] Market pulp consists of domestic or imported pulp purchased from a mill not under the same ownership control as the purchaser.
[b] Not available.
[c] End of year.
[d] Shipments by domestic pulp mills to domestic paper and paperboard mills. The difference between shipments and receipts may be explained in part by "in transit" pulp and probable incomplete reports on domestic shipments.

Note: Detail may not add to totals because of rounding. Data on imports from Canada and Newfoundland also include shipments from all other North American countries, such as Mexico. Data on imports from Europe also include shipments from all overseas sources.

SOURCE: Prepared by Pulp and Paper Section, Forest Products Division Office of Domestic Commerce, based upon data from Bureau of the Census, U. S. Department of Commerce. Data for 1949 preliminary.

gerous." Market pulp stocks, in fact, had not been at so low an ebb for several years and were sufficient on November 1 for only 33 days' operations, as compared with stocks permitting 58 days' operations only five months earlier.

Wood pulp prices, as regularly quoted in the trade press, are quarterly contract prices of pulp sold by independent pulp producers—both domestic and foriegn—and by integrated mills (from surplus over their own requirements) to converting mills, principally in the nonintegrated category. The pulp market, therefore, primarily reflects the rise and fall of the need for pulp by the nonintegrated mills, in relation to the changing pattern of pulp supplies available for purchase. Apart from contract pulp, there is spot pulp periodically available for immediate delivery, at prices usually below the contract figures. An appreciable portion of the spot pulp is often of foreign origin, as was the case during the latter part of 1949. Though not customarily of large relative volume, spot pulp exerts a definite and sometimes a potent influence on the condition of the pulp market. Mill receipts of market pulp in 1949 came approximately 45% from domestic sources, 35% from Canada, and 20% from Northern Europe, chiefly Sweden and Finland. Prices of Canadian and domestic pulp tend, to a considerable degree, to seek a common level, as do the prices of pulp furnished by the three chief Northern European countries.

The easement of pulp supply early in 1949 brought a lowering of first quarter pulp prices which, though described by some trade observers as a break, were regarded in the main as merely an elimination of the premium formerly paid by pulp-consuming mills during a period (1948) when the extraordinary demand for paper and board permitted a profitable use of pulp even at disproportionate price levels. Specifically, contract prices covering bleached and unbleached kraft and unbleached sulphite were lowered for first quarter delivery, while prices of the other major grades remained unchanged from the last quarter of 1948.

Pricing of domestic and Canadian pulp, after the start of 1949, reflected a renewed period of competition between the constituent units of the industry in the two countries. Overseas pulp shippers, though effecting first quarter price reductions in several grades, were not yet on a competitive basis, pricewise, with domestic suppliers.

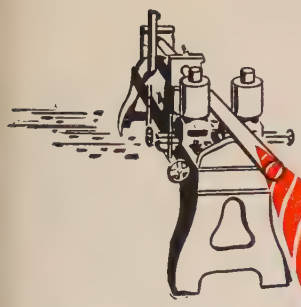
In the second quarter of 1949, domestic and Canadian producers offered pulp at prices predominantly lower than those of the first quarter, with the exception of those for bleached sulphite. Overseas suppliers, too, by reducing second quarter prices across the board, brought all grades—apart from bleached sulphite—down to a competitive level with North America's prices for the first time since the end of the war.

The third quarter witnessed a general reduction of contract pulp prices by North American producers. This over-all adjustment, which represented a decline of 6 to 20% below second quarter prices, reflected the prevailing surplus over demand in virtually all grades. Overseas pulp shippers, though also lowering their third quarter pulp prices, remained on a truly competitive basis with North American producers only in the case of bleached and unbleached sulphite.

A third quarter event of potential significance in respect to the domestic pulp market was the 30% currency devaluation put into effect by the North European pulp-producing countries, as well as by others. Although this action would have enabled the North European pulp suppliers to reduce their prices below the competitive levels of many domestic and Canadian mills, this eventuality did not occur and—apart from a temporary price drop on substantial tonnages of unbleached kraft from Sweden—overseas pulp producers maintained third quarter prices throughout the fourth quarter, and into the first months of 1950. As such, they remained generally competitive with the year-end prices of North American producers, whose anxiety during a period of several months over the possibility of cut-throat overseas price-cutting turned out to be unwarranted, at least for the time being. During the latter months of 1949, the increasing domestic demand for pulp, as well as shrinking inventories, supported domestic pulp prices on a steady basis, though any upswing was discouraged, according to trade analyses, by the overhanging possibility of overseas price cuts. Contract prices of virtually all grades of wood pulp offered by domestic producers and by producers in all foreign areas supplying the United States market maintained, in the first quarter of 1950, the stability that had featured the final months of the previous year. Some cheaper spot sales of the unbleached grades in limited quantities were in evidence but no further cuts were anticipated in the trade, in view of the sustained pulp demand expected for the intermediate future.

Domestic demand for market wood pulp—dependent, as it is, upon sources outside the United States for more than half of its supplies—is sensitive to changing conditions in the several countries of origin. Canada, which accounted in 1949 for more than one third of our market pulp, experienced some diminution of total pulp production early in the year. Despite this trend, a new pulp process was consummated by Canadian research whereby the wood fibers were curled, thus enabling a wider range of pulp quality and an increasing yield. Mid-1949 reports indicated an expansion of Canadian production of the chemical grades which comprise over 85% of her total pulp exports to the United States. Promise of ample pulpwood deliveries gave assurance of no hindrance to pulp operations on that score.

Canadian pulp production in 1949, according to industry estimates, was slightly higher than in 1948. Although a somewhat smaller portion of total Canadian mill shipments of pulp went to the United States in 1949, we still received three fourths of all Canadian pulp that was not retained for use by her own mills. The outlook, in fact, is for continued satisfactory relationships between Canada and ourselves in respect to wood pulp, with the only uncertain factor being the effect which the British cut-back of Canadian pulp imports—stemming from the availability of cheaper Scandinavian pulp as a result of devaluation—will have indirectly on prices to us of Canadian pulp.



SPIRAL WOUND PAPER TUBES. Glued! For food containers. With **PERMATUBE**—a new National cold resin adhesive.

Successful runs have been completed at 100 feet a minute.

Nice margin of safety. On cold or heated mandrels.

PERMATUBE handles soft or hard paper. Transfers smoothly to web.

Doesn't build up on scraper blades.

PERMATUBE easily withstands 30 minute hot coffee and boiling water tests. Imparts no taste to contents.

All users keep re-ordering!

100 FEET A MINUTE!

National ADHESIVES

Address: 270 Madison Ave., NEW YORK 16; 3641 So. Washtenaw Ave., CHICAGO 32; 735 Battery St., SAN FRANCISCO 11, and other principal cities. In CANADA: National Adhesives (Canada) Ltd., TORONTO and MONTREAL. In ENGLAND: National Adhesives Ltd., SLOUGH.

OK! SHOW US! We'd like to see National's PERMATUBE perform in our plant.

☐ **Please demonstrate it on** _____

☐ **Please send trial quantity at drum price.**

Mr._____

Company_____

Address_____

City_____ Zone_____ State_____

EVERY TYPE OF ADHESIVE FOR EVERY INDUSTRIAL USE

Wood Pulp—Year-End Inventories[a]: 1941–1948

(1000 Short Tons)

	1949[b]	1948	1947	1946	1945	1944	1943	1942
Wood pulp, total	516	710	710	490	555	333	427	872
Sulphite, total	269	370	369	232	299	196	256	492
Bleached	131	157	163	107	127	152	184	287
Unbleached	138	213	206	125	173	44	72	205
Sulphate, total	149	226	244	176	179	66	67	238
Bleached	70	67	65	36	39	22	24	57
Semibleached	5	7	7	4	6	5	4	16
Unbleached	74	152	171	135	135	39	39	165
Soda	16	24	22	17	12	16	15	28
Groundwood	65	74	63	56	53	41	71	83
Miscellaneous	17	16	13	9	12	14	19	31

[a] Data for 1945, 1946, 1947, and 1948 are for pulp and paper mills only; data for other years also include wood pulp inventories held by companies outside the pulp and paper industry, e.g., pulp held by producers of explosives, rayon, molded products, etc.
[b] Preliminary data for December 31, subject to revision.
SOURCE: Prepared by Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce, based upon data from Bureau of the Census, U. S. Department of Commerce (figures for 1945–1948); Forest Products Bureau, War Production Board (figures for 1941–1944).

The North European pulp market, as a result in great measure of the curtailment of exports caused by the intense resistance of United States consumers to high Scandinavian prices during the latter part of 1948, began the accumulation of seasonally abnormal pulp stocks in 1949. In the case of Sweden in particular, a delayed revival of some important Latin-American outlets, a decline in some European markets, and a restriction on purchases by Bizone Germany contributed to the pile-up of Swedish stocks. By mid-summer of 1949, stocks of wood pulp in North Europe, as a whole, reportedly approximated one-half to three-quarter million tons. Toward the end of 1949, however increased shipments of North European pulp to the United States, as well as to other reawakened world markets, had reduced over-all North European pulp stocks to more normal levels—some 45% below the position in the early summer. In the case of Sweden, year-end stocks were approximately 40% below the year's high point and year-end pulp operations were around 90% of capacity. Finnish pulp stocks closed the year 1949 more than 50% below the levels of early summer, with operations at a near-capacity tempo. Reports indicate that the North European pulp industry anticipate a 1950 outlet in the United States for wood pulp tonnages well in excess of the 443,000 tons shipped to this market during 1949.

The international significance of a balanced wood pulp supply was pointed up dramatically at a world pulp conference held in Montreal, April 25 to May 4, 1949, under the sponsorship of the Food and Agriculture Organization of the United Nations. The interchange of information at this meeting resulted in an estimate that world production and requirements of wood pulp would be in approximate equilibrium until 1955. An unused pulp capacity in excess of 5 million tons (of which 4 million tons were in Europe, and 1 million in Japan) was computed to have been in existence in 1948. Of the world total in 1948, it was estimated that North America produced 68% and consumed 71% of all wood pulp. The United States in 1947 produced 40% of the world output, consumed over 50%, and purchased (imported) 47% of total world exports.

Another important international meeting was that on trade agreements at Annecy, France, at which unbleached sulphite and unbleached sulphate wood pulp were bound free in the case of Finland and Sweden. Chemical screenings and bleached sulphite—both rayon and paper grades—were bound free in the case of Finland. These bindings will become effective for all countries when the Annecy agreements have been ratified.

A factor of interesting possibilities for the United States pulp market was the reported offer, during 1949, of indeterminate tonnages of chemical pulp from Russia and Czechoslovakia. Although prices were reported to be currently lower than prevailing contract levels, there is no information that United States consumers have availed themselves of those opportunities to any extent.

Total United States imports of pulp in 1949 were somewhat in excess of $1^{3}/_{4}$ million tons, or 19% less than 1948. Canada, in each year, furnished nearly three fourths of the total, with Northern Europe supplying the remaining one fourth. Of the pulp received from Canada, approximately half was market pulp, while the remainder represented pulp shipments to affiliated mills in the United States.

Special pulp developments in the domestic field during 1949 included the inauguration, by a prominent company in the Pacific Northwest, of the use of magnesium oxide as a cooking acid base in sulphite pulp processing. This method is expected not only to enable recovery of chemicals for reuse, but also to produce sufficient heat and energy to supply a large portion of the necessary power to operate the mill. This development is regarded as significant to the sulphite pulp and paper industries, and the reduction in stream pollution it affords is being watched with keen interest by sanitation authorities in the Northwest and elsewhere.

The grades of bleached sulphite known as dissolving pulp encountered a declining demand from their chief customer, the rayon industry, during the first part of 1949. From a low point in April, however, manufacturers' deliveries of rayon staged a steady recovery and the full year's production, though well below that of 1949, was appreciably higher than in 1947. Correspondingly, dissolving pulp followed the renewed upward movement of its major outlet and its production was in full swing at the year's end. Confidence in the broadening domestic market for dissolving pulp is highlighted by the approaching completion of two new mills in North America, one in Mississippi and one in British Columbia. In addition, projected plans have been announced in the trade press for additional dissolving pulp mills in continental United States and in Alaska. A recently announced domestic mill for the production of cellophane should add substantially to the present demand for dissolving pulp, which is the principal raw material of that type of cellulose sheeting.

The year 1950 opened upon a wood pulp market that, with few exceptions, is generally firm. Most mills in this field are operating on a capacity or near-capacity basis and labor-management relations continue to exhibit the mutual respect and consideration which has long been characteristic of the industry. Prices remain steady at the levels of the past six months and most mill executives anticipate the maintenance of stable price levels well into the first half of the year. Demand for virtually all grades exhibits a strong tone. Though more insistent in the bleached categories, some important regions detect a firming tendency in the unbleached grades.

Questions that call forth the industry's continued ingenuity include: stream pollution; possible adjustment of railroad freight rates; the provision of increasing tonnages of wood pulp to care for the normal growth of paper and board manufacture and nonpaper pulp products; the improvement of pulping processes for various hardwoods and other species that may be utilized as replacements for more favored species now in decline; the finding of new market pulp supplies to take up the slack of those integrated mills which, at least temporarily, are utilizing most of their pulp capacity; and preparation for possible future competition with lower-priced foreign pulps.

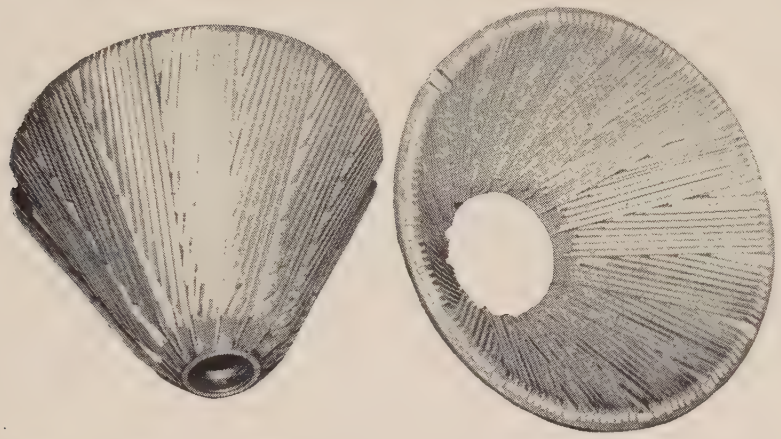
Notwithstanding these and other challenging problems, the wood pulp industry reportedly looks forward with assurance to another year of successful accomplishment in making available to the paper and board industry adequate and fairly priced tonnages of their essential raw material.

Waste Paper

Domestic use of waste paper for the manufacture of paper and board in 1949 reached a total of $6^{1}/_{2}$ million tons. Although this substantial volume was well above normal consumption levels for the prewar and early war periods, it does represent an appreciable decline from the extraordinary waste paper requirements of the late war years and those of the immediate postwar era.

ANNOUNCING

FABRICATED SHELL - PLUG LINERS FOR HERMANN CLAFLIN REFINERS



No. 2 CLAFLIN LINERS—1/4" STAINLESS STEEL BARS

Furnished in Chrome-Manganese Steel, Stainless Steel and Bronze Bars.
Bar Widths—3/16", 1/4", 3/8, 1/2", 3/4". Furnished with and without wood fillets.

VERSATILITY

Continuous beaters—kraft, sulphite, mixed furnish, cotton linters. Cycling operation with beaters, pulpers and cycling tanks. Also one-pass operation prebeating soda, sulphite and kraft pulps separately before mixed refining. Final control of liner-filler stocks direct to cylinder molds. No. 1 Claflins (8) with 1/4" fillings. Preparation of facial, napkin and tissue grades with Claflin only. Deinked-sulphite pulp. Intermediate and final preparation—.009 semichemical corrugating. Hot brown stock brushing before washers. Bagasse, straw, screenings, chip, filler.

SPECIFIC OPERATING INFORMATION FURNISHED UPON REQUEST

THE HERMANN MANUFACTURING CO.

Also Mfg's. of TAPPI Standard Pulp Testing-Sheet Making Apparatus

C. L. KOERNER
7604 S. E. 17TH STREET
PORTLAND 2, OREGON,

LANCASTER, OHIO

HOMAD SERVICES, LTD.
1445 CRESCENT STREET
MONTREAL 25, P. Q.

Waste Fibrous Materials—United States Annual Receipts, Consumption, and Inventories

(1000 Short Tons)

Item	1949[a]	1948	1947	1946	1945	1944[b]	1943[b]	1939
Receipts, total	7682	9233	9434	8895	8195	8359	7224	[c]
Waste paper	6467	7670	7875	7487	6824	6937	6067	[c]
Rags	374	417	445	427	392	431	401	[c]
Other	839	1146	1114	981	978	991	750	[c]
Consumption, total	7763	9149	9535	8660	8143	8245	7564	5526
Waste paper	6553	7649	8009	7278	6800	6859	6368	4366
Rags	383	425	462	403	414	428	426	468
Other	827	1075	1064	980	929	957	770	692
Inventories, total	994	1129	1087	1078	839	837	553	[c]
Waste paper	392	517	521	515	327	315	249	[c]
Rags	56	58	67	77	53	79	71	[c]
Other	546	554	499	486	460	443	213	[c]

[a] Preliminary.
[b] 1944 receipts and inventories and data for 1943 were reported by a few mills other than paper and paperboard mills. Data for the remaining years are for paper and paperboard mills only.
[c] Not available.
SOURCE: Prepared by Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce, based upon data from the Bureau of the Census, U. S. Department of Commerce, and Forest Products Bureau, War Production Board.

During the year just ended, for the second time in the past decade, the country-wide salvage of waste paper has become a matter of serious concern. The previous occasion was during the war, when insatiable demands for packaging stimulated waste paper collections on a scale never before approached. The second attempt to meet a crisis in waste paper was decidedly less gratifying to all concerned, especially to those engaged in accumulation and sale.

The top-heavy position in which waste paper found itself during early 1949 resulted from a combination of factors. On the supply side of the picture, abnormally mild weather in the fall of 1948 and the early winter of 1948–1949 led to the accumulation of stocks of most commerical grades in quantities well in excess of mill requirements. Even the traditionally firm market for the high, or pulp substitute, grades softened around the turn of the year. Old corrugated containers, in fact, were the only so-called bulky grade to be in approximate balance with demand. Folded news and No. 1 mixed, the other widely used bulky grades, were definitely in surplus.

The market situation, uncomfortable as it was for many dealers, with warehouses stored to capacity with unwanted stocks, was further aggravated by influences causing a drop in waste paper consumption. Among these were a decline in folding box production and a trend away from the waste paper-consuming "jute" liner board toward the higher quality kraft board using, for the most part, virgin wood pulp. An increasing use of defibrated pulp also made inroads into waste paper consumption. The changing economic relationship between wood pulp and waste paper usage is clearly manifest in data covering the past two years. In 1948, wood pulp represented 59% of all fibrous material consumed in paper and board manufacture, while waste paper represented 35%. In 1949, wood pulp was 64% and waste paper had dropped to 31% of the total.

A pile-up of the bulky grades in the first part of 1949 made the problem of their handling principally one of disposal, and dealers in some of the large centers were forced to dump and burn a substantial portion of their collections. Their financial problem was somewhat alleviated by requiring the owners and managers of stores and buildings in some cities to pay as much as $5 to $10 per ton for the removal service, instead of receiving compensation for their accumulated waste.

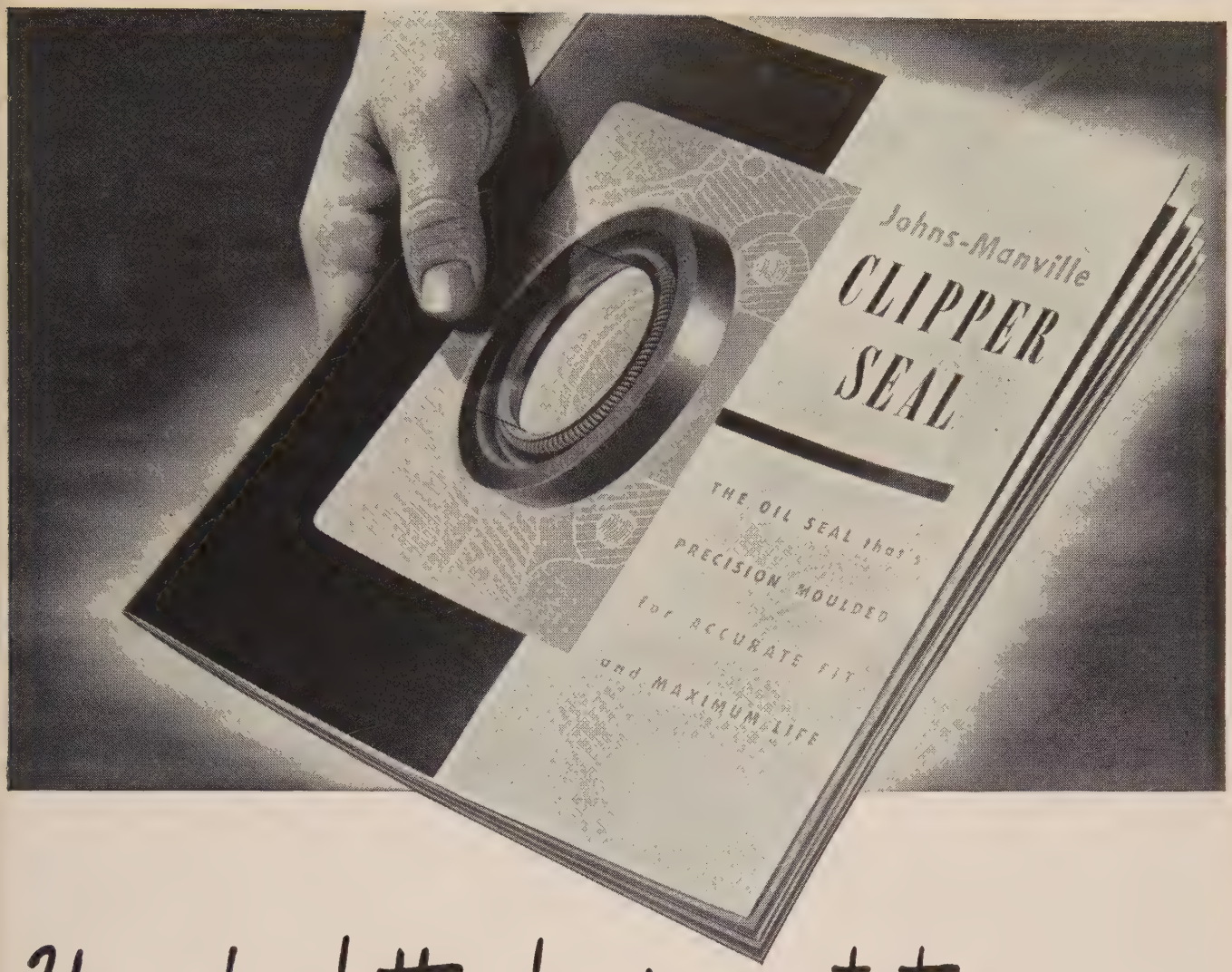
Waste paper prices in the leading markets of the East and Midwest reflected the impact of an excessive supply upon a restricted mill demand during the first six months of 1949. Some grades, notably No. 1 mixed had suffered a price decline during 1948 of almost 50%, and the market generally ended 1948 with prices at or near the year's low point. During the first and second quarters of 1949, prices fell below even the former lows and many dealers were taking a dim view of the immediate outlook in their chosen field.

At this juncture—in July—representatives of the waste paper industry met in Washington, D. C., with officials of the Department of Commerce for a discussion of practical ways and means to relieve the current distress of many in the trade. It was admitted that the situation had resulted from a combination of economic circumstances highlighted by an almost unavoidable accumulation of waste paper stocks in the face of a decline in production of the leading waste-consuming paperboard items, as well as a growing substitution of wood pulp for waste paper in some important products. Admittedly, the position was not susceptible to any superficial panacea. Suggestions that gained favor at the meeting were the promotion of intensive research efforts to develop new uses for waste paper, and the broader application of grade standards and trade practices. The implementation of the standards and trade practices adopted earlier in the year by the national association offered a readily available means of stabilizing the waste paper industry, and of creating sound buyer-seller relationship between packers, dealers, and consuming mills.

Shortly after this meeting and subsequent to the July industry holidays which reduced waste paper consumption to a low point for the year, the tide turned in paper and paperboard production. With the increased output—particularly in paperboard which utilizes over 80% of total waste consumption—the demand for waste paper turned generally upward. August was the first month since March to show an upswing in consumption and the trend continued sharply upward through October, in which month more waste paper was used than in any previous month since May, 1948.

As a result of the improving demand and the tightening supply (which was accentuated by a decline in the activities of peddlers and other collectors that had persisted for a great part of 1949) waste paper prices strengthened appreciably during the third and fourth quarters. Prices generally ended the year on a relatively firm basis, at levels well above those quoted at the close of 1948. All grades of waste paper did not move uniformly, in respect either to demand or prices throughout 1949. The distribution of No. 1 mixed, in fact, remained a problem well into the fall of the year when, however, its supply reached a relative balance with demand and its market position achieved a comparative firmness. Folded news, like No. 1 mixed, was in excess supply throughout the first portion of 1949 but began in August to experience a demand more commensurate with its availability. Corrugated, in comparison with the other popular grades, was in comparatively brisk demand throughout most of the year, with prices moving downward only in the second quarter. The high grades of waste, apart from an early 1949 weakness stemming from the cheapness of wood pulp for which they often are substituted, were in fairly persistent demand throughout the year.

Among the factors that have posed perplexing problems to the profitable operation of waste paper recovery is the matter of increased railroad freight rates. According to industry executives, these high transportation costs automatically restrict the radius of the consuming mills' supply area if they are to operate competitively with other producers to whom waste paper is more immediately accessible. Another factor is the preference for wood pulp stressed by the improvement during recent months in the quality of many papers and boards. The consuming mills, moreover, have become progressively more insistent upon waste paper stock that conforms to accepted standards of quality and packaging. Some packers are meeting this challenge by marketing waste paper under distinguishing trade names intended to serve as guarantees of quality. A broad extension of this movement would no doubt provide the same sales stimulant and marketing stability to waste paper as it has to innumerable other commodities sold under standard brands.



Yours for better bearing protection

—this new book about OIL SEALS

Here is a book filled with useful data about oil seals that you're sure to want for your files. It gives the complete story of the Johns-Manville Clipper Seal . . . tells how this precision oil seal with the one-piece moulded body is providing better bearing protection at lower cost in many types of applications.

Here you will find photographs and diagrams of typical Clipper Seal installations; information on the various lip designs that provide a choice of bearing surfaces; the wide range of sizes that are available; the thick or thin flanges designed for the precision sealing in many bearing housings.

Here are Clipper Seals that help cut maintenance costs and down time . . . seals that are designed specially for quick, easy application where space is limited . . . for resistance to corrosive attack . . . for high temperature operation and other special conditions.

Whether you are concerned with the design or maintenance of equipment, this new Clipper Seal book can help you get better bearing protection at lower cost. Send for your copy today.

JUST FILL IN THE COUPON BELOW

JOHNS MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

Johns-Manville
Box 290, New York 16, N. Y.

Please send me the new Clipper Seal Book (PK-46A).

Name_____

Company_____ Position_____

Address_____

City_____ State_____

Paper and Paperboard—United States Production: 1939–1949

(1000 Short Tons)

Type of product	1949[a]	1948	1947	1946	1945	1944	1943	1942	1939
All types	20,304	21,922	21,114	19,278	17,371	17,183	17,036	17,084	13,510
Paper, total	10,345	11,148	10,795	9,787	8,457	8,220	8,415	9,115	7,484
Newsprint	916	876	833	773	725	721	811	967	954
Groundwood	805	808	821	776	636	593	586	610	540
Printing	574[a]	545	546	474	351	314	356	341	81
Converting and other	231[a]	263	275	302	285	279	230	269	460
Book paper	2,152	2,339	2,208	1,933	1,501	1,436	1,593	1,704	1,535
General printing	1,639[a]	1,837	1,697	1,458	1,111	1,034	1,150	1,190	1,132
Converting	495[a]	484	498	457	380	400	437	507	375
Other book paper	18[a]	18	13	18	10	2	7	7	28
Fine paper	1,027	1,141	1,172	1,160	1,001	974	1,021	1,055	723
Writing paper	801[a]	909	918	902	799	777	814	832	595
Cover and text	62[a]	72	83	93	59	52	48	46	32
Bristol	82[a]	88	87	97	79	84	99	109	79
Thin paper	62[a]	73	73	65	60	58	54	59	17
Other fine paper	20[a]	..	..	3	3	3	5	9	[e]
Coarse paper, total	2,827[a]	3,025	2,903	2,690	2,403	2,314	2,262	2,526	2,168
Glassine, greaseproof and vegetable parchment	123[a]	135	156	158	140	139	144	135	75[n]
Wrapping	792[a]	733	667	763	715	650	687	955	1,061[f]
Bag paper	669[a]	686	540	524	365	375	518	661	654[g]
Shipping sack	480[a]	617	671	550	423	392	315	251	[e]
Converting	763[a]	854	869	695	760	758	597	526	379
Special industrial paper	270	316	289	272	238	245	208	188	71
Sanitary paper	956	983	894	861	824	808	806	811	357
Tissue paper	199	205	195	184	157	158	163	171	291
Absorbent paper	80	107	100	103	89	90	88	65	122
Building paper and insulation	1,113	1,348	1,289	1,036	883	881	878	1,001	659
Other paper	..	..	..	..	..	..	..	16	64
Board, all types, total	9,959	10,773	10,409	9,490	8,914	8,963	8,620	7,969	6,025
Container board	4,610	5,079	4,944	4,315	4,131	4,228	4,088	3,755	3,361
Folding boxboard	2,055	2,182	2,257	2,317	2,092	2,116[h]	2,047[h]	1,712[h]	1,360[h]
Set-up boxboard	601	596	595	521	721	750[i]	829[i]	997[i]	865[i]
Cardboard	72	87	92	89	71	70	64	54	59
Building board	882	1,270	1,072	956	895	1,087[k]	1,064[k]	1,052[k]	115
Wet machine board	121	134	150	138	112	130	121	86	[e]
Other board	1,618	1,425	1,300	1,154[m]	891	581	408	313	265

[a] Preliminary. Data on the production of the minor grades of paper estimated by the Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce on the basis of the pattern shown during the first eleven months.
[b] Comparability of the 1941–1945 data with statistics for earlier years is affected to some extent by the inclusion of statistics for a few companies not previously covered and by certain classification changes. Data prior to 1941 are reasonably comparable with later years, with the exception of Tissue paper, Building paper, and Building Board. (For further details see Census of Pulp Mills and of Paper and Paperboard Mills, 1942.)
[c] Estimated.
[d] Includes cup stock; subsequently included in folding boxboard.
[e] Not shown separately.
[f] Includes some bag paper and special industrial paper.
[g] Includes shipping sack paper.
[h] Prior to 1945 includes all grades of bending board.
[i] Prior to 1945 includes all grades of nonbending board.
[j] Includes clay-coated folding boxboard.
[k] Includes liner for gypsum and stock for laminated wallboard.
[l] Estimated for 100% of the industry.
[m] Includes bending and nonbending board not for use in box plants.
[n] Includes no vegetable parchment.
SOURCE: Prepared by Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce, based upon data from Bureau of the Census, U. S. Department of Commerce.

*Manufacturers—Paper and Paperboard**

Paper and board production in the United States during 1949, at 20.3 million tons, was 1.6 million tons or 7.4% below the peak production record established by the industry in 1948. The decline was shared by all major paper classifications, with the exception of newsprint which registered a gain of 4.5% over the 1948 output. In the board field, the drop in output also was general, with only the set-up boxboard and miscellaneous paperboard groups showing increases over 1948.

Demand at the mill level, and consequently production of paper and board, began to weaken in the closing quarter of 1948 and extended through the first three quarters of 1949. However, actual ultimate consumer consumption during this period was apparently well maintained, so that there was a using-up of excess pipeline inventories accumulated in 1947 and through most of 1948; in fact, inventories of some grades were reported overdrawn in the second and third quarters of 1949. This readjustment period brought supply and demand for most grades into close alignment by the final quarter of 1949.

From March through July, 1949, shipments on most items were established on a current basis. Mills were seeking more orders to maintain machine time and selling competition caused price decline. The 1947–1948 practice of placing duplicate orders in the hope of obtaining delivery of one was abandoned and data on new and unfilled orders assumed more realistic significance.

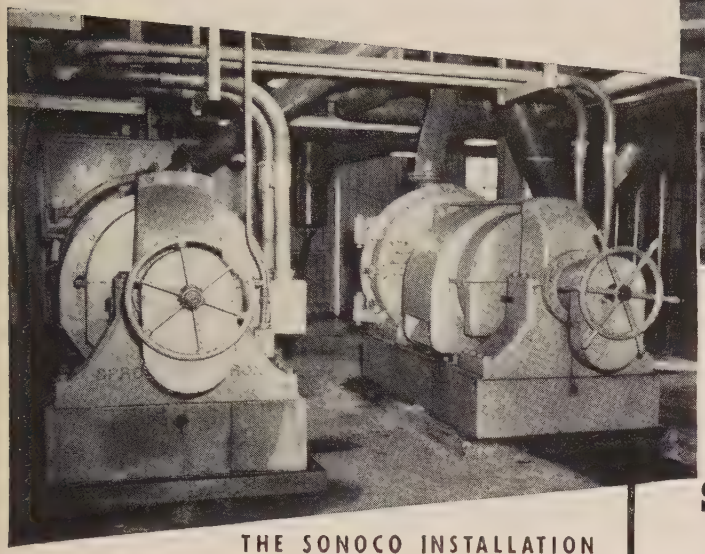
Marginal mills, especially those producing highly competitive grades, felt the pinch during this period and a number of them shut down completely or reduced the work week, as mill supply exceeded demand and competition for markets became keener. Some of the more efficient of these marginal mills underwent major repair and modernization programs during their shut-down period and resumed operation in the last quarter of 1949, when the demand for most grades increased and delivery schedules lagged. Even a number of the large integrated mills shut down for temporary periods in mid-year to allow order files to build up. Very few mills were able to maintain full-time capacity operations during the 1949 summer lull.

Near-capacity operation schedules were resumed during the last quarter of 1949, as buyers entered the market with heavy ordering, and the estimated production of all grades during that period was nearly 5% above the comparable three months of 1948. Because of lack of sufficient current data on inventories in all consuming channels, it is not known how much of the increased tonnage produced during the closing months of 1949 was used to replenish depleted stocks and what percentage was for current use. Reports from the various sections of the country, however, indicate that printers', converters', and distributors' stocks of most items were back to normal levels by January, 1950, and that current demand is closely related to actual use.

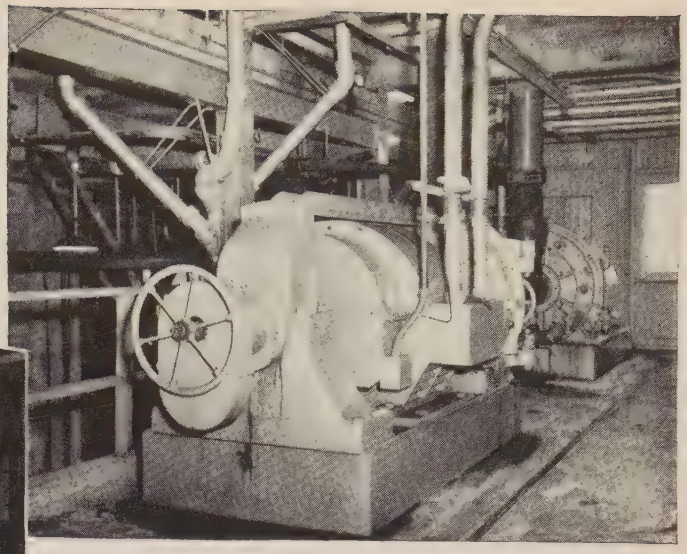
* Section on Manufacturers—Paper and Board—Prices prepared by JAMES J. SULLIVAN.

Mills that compare

Refiners



THE SONOCO INSTALLATION
Hartsville, S. C.
Showing Sprout-Waldron Refiners for Semi-Chemical Pulping



choose

Sprout-Waldron

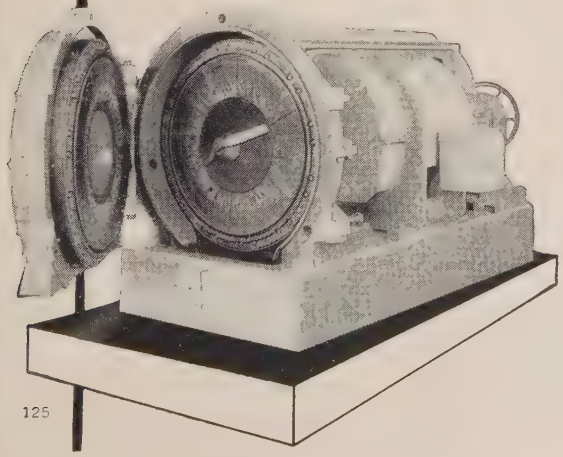
The many recent installations of Sprout-Waldron Refiners for semi-chemical pulping prove—that **Sprout-Waldron Refiners are definitely preferred for this type of operation**

But these rugged, precision engineered Refiners can do **any** kind of pulping—do it well and with great economy. Their exclusive peripheral control ring feature provides great flexibility of adjustment, so that you can produce a wide variety of pulp characteristics. With the S/W Refiner you can pinpoint exact pulp requirements.

Initial investment is comparatively low, and inexpensive long-life plates are available in many styles. High production rates; economy in power consumption; ease of operation, adjustment, and maintenance give you other important advantages.

Our representative will be glad to explain how Sprout-Waldron Refiners can increase your output and save operating costs . . . or let us send you our Bulletin R-748. Address Sprout, Waldron & Co., Inc., 38 Waldron Street, Muncy, Penna.

S/W Refiners do a wide variety of jobs—all of them thoroughly and economically. Here are some applications: refining kraft, soda, and sulphite knotter and fine screen rejects; hogged bull screen rejects; knotter and second screen rejects of raw groundwood; *semi-chemical chips of all kinds;* spent chips after extraction process; bagasse, straw, and similar grasses; breaking down lumps in reclaimed waste paper stock; reduction and refining of rag and other half stocks, etc., etc.



125

Sprout-Waldron
Manufacturing Engineers
SINCE 1866
MUNCY • PENNSYLVANIA

Newsprint—United States Production, Imports, Exports, Domestic Consumption, and Inventories

(1000 Short Tons)

Item	1949[a]	1948	1947	1946	1945	1944	1943	1942	1939
Production	916	876	833	773	725	721	811	967	954
Imports	4637	4395	3958	3492	2699	2491	2637	2921	2615
Re-exports[b]	5	2	2	2	3	9	2	2	1
Exports	39	28	28	28	44	31	35	42	13
Total supply[c]	5509	5241	4761	4235	3377	3172	3411	3845	3555
Inventories, total[c]	457	467	386	308	273	350	378	489	341
Publishers'[d]	446	458	377	293	266	342	367	479	328
Mill	11	9	9	15	6	7	11	10	13
Change in stocks[e]	−10	+81	+78	+35	−77	−28	−112	+96	+8
Apparent total consumption	5529	5141	4753	4296	3481	3243	3627	3816	3546

[a] Preliminary.
[b] Re-exports of newsprint included in the general import statistics.
[c] Totals may not add because of rounding.
[d] Reported by 422 publishers of 525 newspapers consuming approximately 77% in 1949; 78% of the newprint consumed in 1948; 75% in 1947; 73% in 1946; 70% in the first half and 71% in second half of 1945; 72.5% in 1944; and 75% in 1943.
[e] Compared with January 1.
SOURCE: Production, import, and export figures, Bureau of the Census, U. S. Department of Commerce; consumption and publishers' inventories, American Newspaper Publishers' Association; mill inventories, News Print Service Bureau.

Industry executives are optimistic in their forecasts for the first six months of 1950, although they are hesitant to extend their predictions beyond the middle of the year. The consensus is that the year 1950 gives promise of more stable operating conditions, with a high level of operation continuing throughout the first half of the year. Prices for most items are expected to remain reasonably steady at present levels.

Reports received from the field offices of the Department of Commerce indicate, with few exceptions, that the high level of operations of the closing quarter of 1949 continued into January, 1950. New orders, however, were reported slower and smaller in volume the first part of January, as wholesalers and retailers held back prior to the usual seasonal buying period.

The seasonal decline in the demand for building paper curtailed production of these grades during the last weeks of 1949. Colder than normal weather in the west and mid-west slowed construction activities. Building felt mills throughout the country are reported to have operated at approximately 65% of potential capacity during December, 1949, and were still on short schedules during the early weeks of 1950.

Newsprint

Production of newsprint in North America during 1949 established a new high at 6,092,000 tons, an increase of 4.2% over the previous high of 1948 and 47.5% over the 1939 output. Canadian (including Newfoundland) mills produced 5,176,000 tons during the past year, a gain of 3.9% over 1948. Mills in Newfoundland increased their output during 1949 relatively more than those in the rest of Canada, reaching a total of 444,000 tons, topping their 1948 figure by 16.2%. U. S. production in 1949, at 916,000 tons, was 4.6% above the 1948 output and was the highest recorded since 1942.

Production of Newsprint in North America

(1000 Short Tons)

Year	Total[a]	United States	Canada	Newfoundland
1949[b]	6092	916	4732	444
1948	5850	867	4601	382
1947	5653	833	4447	373
1946	5279	773	4143	363
1945	4317	725	3259	333
1944	3985	721	2992	273
1943	4030	811	2983	236
1942	4422	967	3177	277
1941	4815	1044	3426	345
1940	4826	1056	3419	351
1939	4129	954	2869	305

[a] Details may not add to total because of rounding.
[b] Preliminary.
SOURCE: United States, Bureau of the Census, U. S. Department of Commerce; Canada and Newfoundland, Newsprint Association of Canada.

American newspaper publishers received the bulk of this increased tonnage. The trend of Canadian exports to markets other than the U. S. was downward. Canadian mills (other than in Newfoundland) increased their shipments to the United States by 4.5%, but their exports to all other countries fell 13.9% below those of 1948. A total of nearly 325,000 tons was exported to the United States from Newfoundland during the past year, an increase of 78,000 tons over 1948. Exports to other markets during the year by Newfoundland mills were nearly 27,000 tons less than those of 1948. A continuation and perhaps acceleration of this trend during 1950 can be expected in the light of the present world-wide dollar shortage and the return to more normal operation by the mills of northern Europe.

Newsprint—United States Imports by Country of Origin

(1000 Short Tons)

Source	1949[a]	1948[b]	1947[b]	1946
Total	4637	4395	3958	3492
Canada[c]	4382	4127	3829	3478
Finland	151	132	84	12
Sweden	37	70	25	1
United Kingdom	35	3	..	..
Norway	30	28	6	..
France	2	28	10	..
All other countries	1	7	4	..

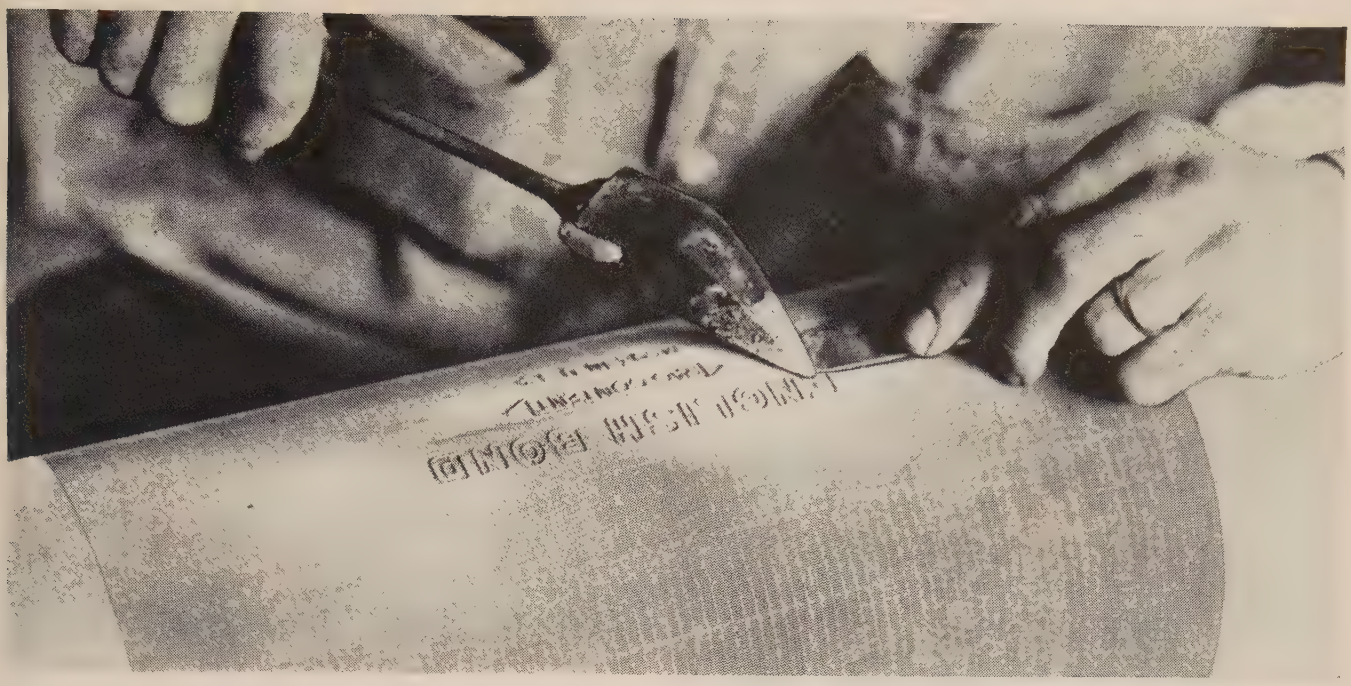
[a] Preliminary.
[b] Revised.
[c] Includes Newfoundland.
[d] Data do not necessarily add to total because of rounding.
SOURCE: Prepared by Pulp and Paper Section, Forest Products Division, Office of Domestic Commerce, based upon data from the Forest Products Branch, Office of International Trade, and the Bureau of the Census, U. S. Department of Commerce.

Imports of newsprint into the United States from countries other than Canada amounted to 254,000 tons during 1949, a decrease of 5.2% over the 268,000 tons imported in 1948. Norway, Sweden, and Finland supply the greatest share of newsprint which originates overseas. Imports of newsprint from other European countries during 1949 were larger than normal, as several of the smaller newsprint-producing countries which usually consume their entire output exported newsprint to the United States to obtain needed dollars.

Newspaper publishers throughout the country took advantage of the increased supply to set a new record for use, and reported the consumption of 5,529,000 tons, an increase of 388,000 tons or 7.6% over 1948 usage. Publishers report that their stocks of newprint on December 31, in terms of tonnage as well as days' supply, were slightly below those of January, 1949.

Although supply and demand were brought into closer alignment during 1949, there was no noteworthy surplus and contract prices remained steady throughout the year. The start-up of the new newsprint mill at Coosa Pines, Ala., in January of this year, and the possible loss of other markets in dollar-short countries by the Canadian mills, indicate that the supply of newsprint available to United States buyers during the current year will be even larger than in 1949. While no reduction in the contract price for newsprint has been reported, two large Canadian producers recently announced the elimination of certain extra freight charges on shipments to some U. S. markets.

Offsetting to a moderate degree this increase in supply has been the reconversion from newsprint to other grades of paper by some U. S. mills which had entered the field during the shortage.



Attaching watermark to a Monel dandy roll at Jos. J. Plank & Company, Appleton, Wis.

MONEL cloth for dandy roll covers...

longer lasting — easy to braze — rustproof

Your dandy rolls will be renewed less often when they are made with Monel®.

Monel wire cloth outlasts other dandy roll cover materials many times. In addition, its smooth seams, flat weave and stiffness help prevent wire marks.

Keep these other important advantages in mind, too...

Monel is 100% rustproof and highly resistant to corrosion by stock on the paper machine. Monel equipment can be kept bright and shining merely by flushing with clean water.

Monel's extra hardness gives extra service life. And, there is no accelerated corrosion between Monel and the machine wire.

Monel has long been a preferred metal in most of the nation's leading board and paper mills . . . for head boxes, stock lines, screens, doctor blades, save-alls, jordan bars, winding wire, rolls, suction boxes and covers.

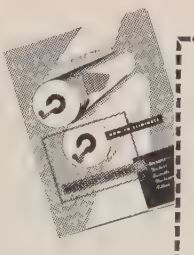
For information on Monel dandy roll covers, write directly to Jos. J. Plank & Company, Appleton, Wisconsin.

And as a first step to cutting costs in your own plant . . . find out how Monel is solving corrosion and production problems in other mills. Fill in and mail the coupon for your copy of "How to Eliminate Unnecessary Shutdowns in Washers, Deckers, Save-alls, Thickeners, Filters."

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
INCO
TRADE MARK



***Monel*... for minimum maintenance**

The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.

Please send ..... copies of *"How to Eliminate Unnecessary Shutdowns in Washers, Deckers, Save-alls, Thickeners, Filters."*

Name.....

Company.....

Title.....

Address.....

Three mills which had been producing small tonnages on contract for newspapers in their immediate area, including one mill purchased by a newspaper during the height of the shortage, returned to the production of their normal grades during 1949. Newsprint from deinked waste paper is still being produced in small quantities. Experiments with annual growth fibers, such as bagasse, continued, but these processes have greater opportunity in certain foreign countries than in the United States.

Recent dispatches from London modify earlier reports and limit the British ban on the importation of Canadian newsprint to the first six months of 1950. At that time, the dollar position will be reviewed with the intention of revising the ban as conditions warrant. A further dispatch from London, dated January 13, announced the relaxation of controls on newsprint to allow the dailies to print up to 50 additional pages at any time between now and March 12. If they wish, the newspapers may use all of the extra space between now and the general elections.

Domestic newsprint mills are reported to have run on full schedule during January, with no price changes indicated as long as demand remains at current levels, or continues the postwar upward pattern.

Groundwood, Book, and Fine Papers

Production of the groundwood, book, and fine grades of paper during 1949 was 7.1% below the high peak set for these grades in 1948 and 5.2% below the 1949 total for this group. Production of these grades during the fourth quarter of 1949, however, was slightly above the output during the comparable period of 1948 as the industry as a whole resumed near-capacity operation. The fourth quarter recovery of this group was due chiefly to the increased demand for the fine paper grades. Output of the groundwood and book printing papers during the closing quarter of 1949 was approximately in the same volume as in the fourth quarter of 1948.

The postwar trend toward conversion of considerable existing capacity from the manufacture of newsprint, uncoated printing papers and base stock for coating to the production of paper machine coated papers continued throughout the past year. Because of this new machine coating capacity, the industry was able, during the year, to effect a close balance between the supply and demand for machine-coated grades.

Reports received from the field offices of the Department of Commerce during January indicate that the demand for groundwood, book, and fine papers continued close to the high levels of the last few months of 1949. The increased demand for book grades is reported to have increased the unfilled orders at the mill level and delivery schedules have lengthened.

Coarse Paper

Although local shortages for some kraft items, especially wrapping grades, still existed at the close of 1949 and delivery dates for most grades were 30–45 days from the date of the order, supply and demand for coarse papers generally were reported in somewhat closer balance during January, 1950. Production during 1949 was 6.6% below the record output of 1948, despite a return to near-capacity operation during the final quarter, when the output of these grades was 17% above the comparable quarter of 1948.

The weekly potential for the kraft paper segment of this group increased during 1949 as new capacity, completed during the year, was put into operation. This new capacity enabled the industry to meet most of the increased demand for its products. New orders placed in the closing months of 1949 were larger in volume than the average for the previous three quarters of the year and unfilled orders on the books for kraft papers on December 31 were substantially greater than on January 1, 1949. Several plants which had shut down entirely or had operated on reduced schedules, starting in the early months of 1949, returned to a full seven-day work week during the fourth quarter of 1949.

The three major subgroups of the kraft paper segment, wrapping, bag, and other converting, shared equally in this upturn in demand and trade reports received through the field offices of the Department of Commerce during the first weeks of 1905, indicate the continuation of the high level of operation into the first quarter of the new year. New orders remained above the weekly average for 1949.

Reports received from the field offices of the Department of Commerce during the first few weeks of the current year indicate that kraft wrapping is in short supply in some areas of the country. Distributors, however, are exercising caution and keeping inventories down to levels slightly below normal.

Sanitary, Tissue, and Absorbent Papers

Production of sanitary paper stock during 1949 was only 2.8% below the figure for these grades in 1948, and the output of tissue papers other than the sanitary and thin grades was 2.9% under the comparable figure for 1948. The production of both of these grades of paper during 1949, however, was the second highest on record, exceeding the 1947 figures by 6.9 and 2.0%, respectively. Reports received from the field offices of the Department of Commerce, as of early January, 1950, indicated that supply and demand for most papers in this group were in balance, with prices firm.

Production of the absorbent grade, however, dropped sharply during 1949, when the output was 26.0% below the 1948 figure and nearly 21% under the 1947 production of these grades. According to the estimates for the fourth quarter of 1949, the demand was still well below the potential capacity of the industry for these grades.

Paperboards

Over-all production of board during 1949 was 7.2% below the record high of 1948. Production of paperboard, however, was only 4.4% below the 1948 output and 2.5% under the comparable figure of 1947; building boards showed a loss of more than 30%.

In the paperboard segment, kraft board production for shipping containers in 1949 showed a slight increase over the 1948 figures. This increase was due chiefly to the increased demand for these grades, coupled with the new kraft board capacity added since the war. The new kraft board mills, erected in the South during the past few years, have increased the supply of kraft liners, as well as corrugating medium, to the volume where kraft board of various types is generally competitive pricewise with jute and other grades. Production of kraft liners was 1.7% over the 1948 output and production of kraft corrugating medium was 41.6% greater in 1949 than in 1948. However, total output of all grades of liners and corrugating board in 1949 was 12.7 and 2.3%, respectively, below the comparable 1948 figures.

Miscellaneous grades of paperboard and the set-up boxboard grades were the only major groups of board to register gains over the 1948 output. While the increase in the production of set-up boxboard was slight, less than 1%, the output of the miscellaneous grades, which includes milk bottle stock and other types of sanitary food container stock, was 13.5% over production in 1948 and 24.5% over the comparable figure for 1947. Large food chain stores are reported to have stimulated the demand for milk bottle stock by expressing a strong preference for the paperboard container over the conventional glass bottle because of the ease in handling and the elimination of deposits and returns. On the other hand, dairies in some localities are reported resisting the trends as they claim the filling process for the paper bottle is slower than for the glass type. The increased popularity of frozen foods also has contributed materially to the increased demand for the grades in this group.

The Department of Commerce Field Offices throughout the country reported a keener competition for most grades of boxboard during January. Mills are continuing to operate at capacity.

The output of building board during 1949 was 30.6% below production in 1948, according to a preliminary report issued recently by the Bureau of the Census. This sharp drop is due primarily to a strike of several months' duration in the mill of one of the larger producers. Another strike in an allied service industry kept the mill of another producer idle during several months of 1949.

Prices

Department of Commerce Field Offices throughout the country report prices for paper, board, and converted products to be generally firm at mill levels but with wholesalers and jobbers making concessions on some items in the face of increased local competition. A few exceptions are reported for some mills striving to maintain the maximum operating schedules of the previous two or three months. Wood pulp prices for second quarter delivery are expected to remain steady at the level of first quarter quotations; a number of pulp sellers have already announced this policy.

DU PONT PIGMENT COLORS *for*

WALL PAPER
COATED PAPER
FLINTED PAPERS
BEATER DYEING

STANDARDIZED PIGMENTS to MEET the EXACTING REQUIREMENTS for PAPER COLORING

THE DU PONT LINE includes economical pigments of highest quality. There are colors for beater dyeing which have been especially processed for quick and thorough dispersion in water. They have better strength than the usual lakes for beater coloring. Use them for papers which must have good lightfastness.

All these Du Pont pigments are standardized for properties important to their use in paper. They may be adapted to the most exacting requirements.

You can get further information from your Du Pont salesman, or by writing to E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, 1007 Market Street, Wilmington 98, Delaware.

DU PONT PIGMENTS for QUALITY PRODUCTION

Chrome Yellow ☆ Organic Yellow Lakes ☆ Soluble Blue
Pigment Green B—full strength and lakes ☆ Molybdate Orange
Dispersible "Monastral" Blue and Green Lakes ☆ Toluidine Red
Watchung Red ☆ PTMA—Blue, Green and Red Lakes

● Tune in to Du Pont "Cavalcade of America," Tuesday Nights—NBC coast to coast

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT PIGMENTS FOR PAPERS

"WELL DONE" says a Southern Paper Co.

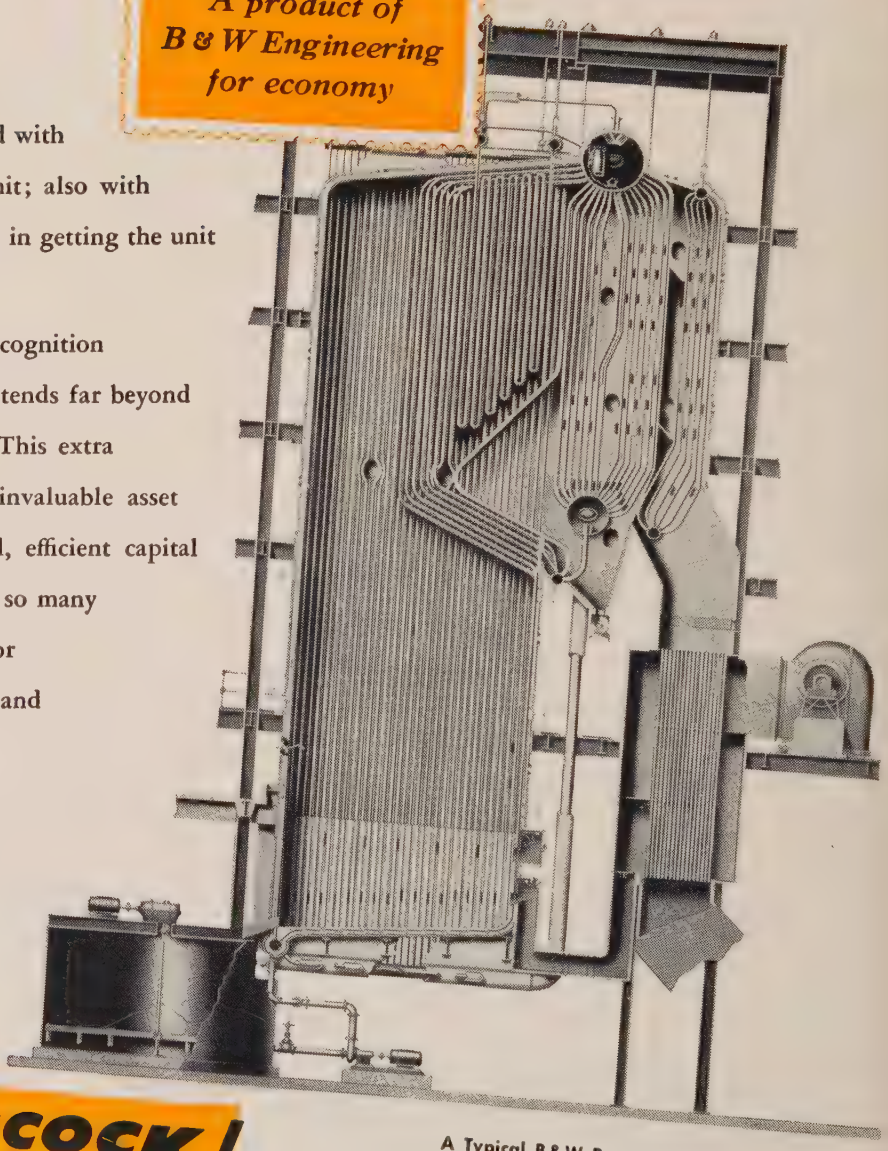
. . . as 2nd B&W Recovery Unit

Goes into Service

A product of B & W Engineering for economy

This customer reported that it was pleased with the performance of the second B&W unit; also with the cooperation given by B&W engineers in getting the unit through when it was needed.

A pat on the back like this is tangible recognition of B&W's service, which traditionally extends far beyond contractual definitions of responsibility. This extra attention to customers' problems is an invaluable asset to executives responsible for economical, efficient capital investment. And it helps to explain why so many companies keep coming back to B&W for dependable, low-cost chemical recovery and steam-generating equipment.



A Typical B & W Recovery Unit

BABCOCK & WILCOX

P-50

The Manufacture of Chemigroundwood Pulp from Hardwoods

C. E. LIBBY and F. W. O'NEIL

A process has been developed for converting aspen, birch, beech, and maple woods into mechanical pulps which may be substituted successfully for spruce mechanical pulp in most grades of paper. It is proposed to identify this new type of wood pulp by the coined name "Chemigroundwood." The chemigroundwood process consists of a mild chemical pretreatment of the wood in block form followed by mechanical defibering in any conventional wood pulp grinder. Chemigroundwood pulp is manufactured more successfully from hardwoods than from softwoods since the coniferous woods do not respond as favorably to this type of chemical treatment. The treated hardwood is ground with one-half to two-thirds the power and at double the production rate of spruce groundwood. The pulp itself is three to four times as strong as ordinary spruce groundwood, standing intermediate in this respect between spruce groundwood and unbleached sulphite pulp. The chemigroundwood process gives pulp yields ranging between 85 and 90% of the weight of the original wood. Most species of hardwoods give chemigroundwood pulps which may be bleached with peroxide or calcium hypochlorite to the same final brightness as spruce pulp and at no greater cost. The high density of the principal hardwoods results in pulp yields that exceed the average yield from the conifers by at least 700 pounds per cord of wood. The value of this additional pulp is several times as great as the cost of the mild chemical pretreatments which are an essential feature of this new pulping process. The Northeastern states have abundant resources of hardwoods that are available at relatively low cost compared to the softwoods. The ample supply of these woods, plus the tremendous advantages in quality and yield of fiber by the chemigroundwood process, presents to the paper industry of this region an unprecedented opportunity to re-restablish the manufacture of wood pulp from native woods on a sound economic basis.

THE growing scarcity of coniferous woods for pulp manufacture, especially in the Northeastern United States, has focused interest on the hardwoods as potential replacements for the diminishing supply of softwoods. In 1948, according to the Department of Commerce, Bureau of the Census, the pulp manufacturing industry consumed a total of 21,189,458 cords of wood of which 18,490,916 cords were softwoods and 2,698,542 cords were hardwoods. Most of these hardwoods were converted to pulp by the chemical processes, only 166,149 cords being utilized for mechanical pulp manufacture in 1947 of which 2818 cords were northern mixed hardwoods. Of the remaining volume of hardwoods pulped mechanically, 159,655 cords were aspen which were utilized largely in the Northeastern and Lake States. However, this species is relatively soft and long fibered and does not present to the pulpmaker problems of the same magnitude as the dense hardwoods like beech, birch, and maple.

C. E. LIBBY, Professor of Pulp and Paper Manufacture and Director of Hardwood Pulping Project, and F. W. O'NEIL, Associate Professor of Pulp and Paper Manufacture and Assistant Director of Hardwood Pulping Project, New York State College of Forestry, Syracuse, N. Y.

Notwithstanding the preference of the pulp industry for coniferous woods and the fact that 87% of the wood supply now comes from these species, statistics indicate that over one-third of the remaining available timber supply in the United States consists of hardwoods and this percentage is rapidly increasing as the reserve softwood supply is further depleted by the present excessive rate of use. Harper (*1*) estimates that in New York and New England where the pulpwood situation is most critical the available timber supply amounts to 493 million cords, of which 178 million cords are softwoods and 315 million cords are hardwoods (Table I).

Table I. Timber Volume[a] in New England and New York, Status Beginning of 1945 (Million Cords).

Softwoods		*Hardwoods*	
Spruce and fir	103	Birch, beech, and maple	248
White and Norway pine	40	Oak	30
Hemlock	28	Aspen	17
Other	7	Other	20
Total	178	Total	315

[a] Trees 5 inches (diameter breast high) and larger; does not include bark. Converting factors: softwood, 1 cord equals 78 cu. ft.; hardwoods, 1 cord equals 65 cu. ft.

According to statistics compiled by the United States Department of Agriculture Forest Service (*1*), plants in New York and New England manufacturing wood products have an annual requirement of nearly 12 million cords from the forests of this region. Another 2 million cords are lost through fires, forest insects, and diseases. The total drain, i.e., the drain for lumber, pulpwood, and other forest products together with the loss by fire, insects, and diseases, amounts to 14 million cords annually of which 40% is softwoods and 60% is hardwoods (Table II).

Table II. Comparison of Annual Drain and Growth, Status Beginning of 1945 (Thousand Cords).

Item	*Drain*	*Growth*[a]	*Surplus*
Softwoods	5,754	6,449	695
Hardwoods	8,040	12,092	4052
Total	13,794	18,541	4747

[a] Annual growth of all trees 5 inches (diameter breast high) and larger, including tops and limbs (tops only in softwoods) of saw-timber and total volume of trees reaching 5 inches (diameter breast high) each year. Bark not included.

Because of the great decline in the volume of softwoods in New York State many mills now are forced to import coniferous pulpwood from Canada. This is costly and a serious disadvantage to economy in New York State mills.

Originally the volume of softwoods in the Northeastern territory exceeded that of the hardwoods. Now the proportions are heavily the other way for only 35% of the present growing stock is softwoods, whereas

65% is hardwoods. The bulk of the hardwood volume, estimated at 80%, is beech, birch, and maple, the three species that the manufacturer of mechanical pulp has had little success in converting into usable fiber. It appears logical that an enterprising and forward-looking industry, a large division of which is concerned with the manufacture of groundwood papers, would undertake a development program to determine if methods could not be found to utilize this vast resource of dense hardwoods in the manufacture of satisfactory mechanical pulps. A successful process of this character should do much to insure the perpetuity of the paper industry in the Northeastern States.

HISTORY OF THE PRETREATMENT OF WOOD FOR MECHANICAL PULPING

Ever since the invention of the groundwood process attempts have been made to develop satisfactory pulps from hardwoods. These investigations have included the grinding of hardwood in the raw state, grinding after boiling, and also following steam treatments in a closed vessel. More recent developments have been the attempts to penetrate the wood blocks with chemical bearing liquors with the objective of softening the binding material between the fibers, followed by grinding in the usual manner.

In 1869 Mortiz Behrend (*2*) discovered that water at 90 to 150 p.s.i. partially dissolved or softened the intercellular wood structure so that fibers could be separated by hand. At 90 p.s.i. the fiber strength was unharmed but the color of the resulting pulp was a dark brown. This procedure was not patented but was used commercially for many years to soften logs before grinding. In 1872 Oswald Mayh was granted a German patent on boiling wood to get a lighter color than by steaming. The difference was not important enough to justify the extra steam costs. In 1880–1882 Resch and Kirchner developed a crushing process (DR18447–19192) in which wood was boiled, steamed, treated in an edge runner, and refined. C. J. Jansson reported in 1878 that by keeping the cooker more than two-thirds filled with water and the pressure less than 30 p.s.i., a bright pulp suitable for bleaching and paper manufacture was obtained in 18 to 20 hours.

L. Enge (DRP20860 and 20932) claimed a light colored product by heating under or over 212°F. at a pressure greater than steam pressure at that temperature (*3, 4, 5, 6*). The original experiments were carried out with a horizontal digester 423.77 cubic feet in volume. The barked logs were charged, the digester filled with previously heated water, and direct steam admitted. Water was bled enough to raise the temperature to 230 to 284°F., then a pressure pump was used to stop boiling. The temperature was maintained for 3 hours with heating coils, or the temperature was allowed to drift down to about 59°F. The logs were softened and became stiff again on cooling. The power consumption in grinding was low (36.2 horsepower days per ton for a very slow pulp).

Typical conditions for a white pulp by the Enge process were given as 230°F., 147 to 176 p.s.i. for 6 hours (average) or 257°F., 230 p.s.i. for 5 to 10 hours (*6*). It was noticed that if the pressure fell to the boiling point the wood was discolored.

In the Bache-Wiig process the wood is impregnated with sulphur dioxide gas after the digester has been previously exhausted of air by a vacuum pump following which water, or a salt solution, or bisulphite liquor is then charged and the wood cooked for 4 to 5 hours. Groundwood pulp from the treated wood gives a strong, white pulp which can be run as a 100% newsprint furnish (*7, 8*). C. G. Schwalbe (*2, 9*) claims to have a process which will make a white groundwood from steamed wood by using a reducing agent such as sulphite liquor, subjecting the wood to a vacuum and digesting with hot water.

In 1914, the St. Regis Paper Company used the Hall process to make 25 tons of newsprint (*10, 11*). This process was a combination of a boiling pretreatment of the logs and a novel method of stone sharpening to reduce the amount of regrinding of pulp on the stone face. The boiling step was found too expensive due to the labor and steam involved so that no over-all saving was made. This step was abandoned but the stone sharpening method was continued. The stone was sharpened with a three-quarter marker and crossed with an 8-cut spiral. This was later changed by substituting a No. 4 marker and a 14-diamond burr. The stone was given light and frequent dressings to give a more uniform pulp.

Bendryshev (*12*) studied the effect of moisture content of spruce wood on the grinding process by increasing the moisture content with a special procedure. The logs were treated (as received, or preheated with steam at 1 atmosphere for 2 hours) by exhausting the digester to a pressure of 60 mm. (27.5 inches vacuum) for 30 minutes, then subjected to a hot water treatment at 90 to 95°C. for 3 to 4 hours at 105 to 120 p.s.i. hydraulic pressure. In general, as the moisture content was increased, the grinder output increased, power consumption decreased, and tensile strength of the paper increased.

A detailed description of the wood-treating equipment used in 1930 at the Sturgeon Falls mill of the Abitibi Power and Paper Company is provided by Lougheed (*13*). The major equipment items were a 32 by 7 foot autoclave of $^3/_4$-inch steel plate holding 5 cords of wood and an 850 cubic foot storage vessel vented to the atmosphere. Spruce and jackpine logs were treated with a solution of sodium sulphite and sodium bicarbonate, just alkaline enough so that the final pH of the liquor was 7.2 to 7.4 to reduce corrosion. It required from 50 minutes to 2 hours to heat to 115 to 125°C., and the treating time varied from $2^1/_2$ to $4^1/_2$ hours. At the end of the cook the turpentine was flashed off, (about 1.2 gallons per cord), the cooking liquor was returned to the storage vessel, and cold water showers were used to cool the logs for grinding. Excessive steam costs were the result of using an open storage vessel with no lagging. Treated wood ground slower than untreated and the power consumption per ton was greater in proportion to the degree of treatment. The pulp was ground with a finer stone, reduced pressure, and higher temperature for a freeness 70 points higher than the raw groundwood. With the treated groundwood it was possible to reduce the spruce sulphite pulp content from 18 to 8% in a newsprint furnish, and 6% was believed possible. The cost saving depended on the sulphite pulp costs and was about $1.63 per ton for a furnish consisting of 56%

spruce groundwood, 35% treated groundwood and 9% sulphite pulp. Penetration of the logs during the cooking process appeared to be about $^1/_8$ to $^1/_2$-inch.

Hyttinen and Schafer (*14*) conducted groundwood pulping experiments at the U. S. Forest Products Laboratory which included untreated and pretreated species of hardwoods. The results indicated that suitable pulps could be made from eastern cottonwood, yellow poplar, hard maple, black tupelo, sweet gum, paper birch, and white ash. Two of these species, paper birch and sweet gum, were pretreated with neutral sulphite cooking liquor using vacuum and hydrostatic pressure. The results of tests made on pulp from pretreated wood and ground on various stone faces from sharp to dull gave physical properties which were somewhat better than the untreated pulps. The pretreated pulps from paper birch had bursting strengths between 0.11 and 0.25 points per pound, tearing strengths of 0.30 to 0.70 grams per pound and freenesses, Canadian Standard, ranging between 95 and 580 ml. The physical properties of the pulp manufactured from pretreated sweet gum were in all instances much lower than these values. The process consisted of a four-cycle treatment described as follows: (1) a half-hour vacuum with wood immersed in the solution (60 grams per liter sodium sulphite, 20 grams per liter sodium bicarbonate); (2) heating the solution to 250°F. with direct and indirect steam and effecting additional pressure above that due to the temperature by injecting direct steam on top of the liquid, increasing the pressure to 140 p.s.i. and maintaining it for $^1/_2$ hour; (3) relieving pressure and applying vacuum for $^1/_2$ hour; (4) repeating No. 2 cycle. The digester was then relieved, the liquor drained and the wood removed. A two-cycle treatment was also used consisting of (1) a 1-hour vacuum stage during which the treating solution was drawn into the digester and (2) a 1-hour pressure stage with the treating liquor at 250°F. and a pressure of 150 p.s.i. total pressure maintained by compressed air. The pressure was then relieved and the liquor drained.

Complete tables containing data of wood evaluation, grinding conditions, power requirements, and physical properties of untreated and treated woods are included.

DEVELOPMENT OF THE PROCESS FOR MECHANICALLY PULPING HARDWOODS

The Hardwood Pulping Problem

The grinding of aspen wood to produce a fairly satisfactory grade of mechanical pulp has been practiced by certain pulp manufacturers for a great many years. While the fibers in this wood are much shorter than those of spruce (Table III), the density is very similar and this factor apparently has more influence than fiber length in determining pulp quality.

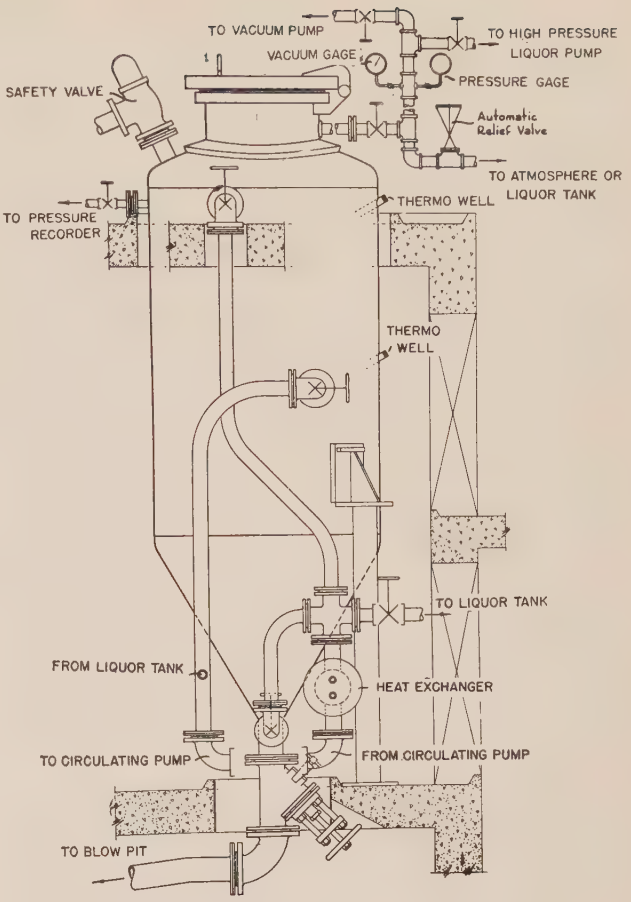


Fig. 1. Digesters used for wood pretreatments

An inspection of the physical properties of the fibrous elements of these woods (Table III) will indicate the magnitude of the problem in manufacturing a mechanical pulp from the hardwoods which even approaches spruce pulp in quality. Of especial significance is the high density of birch, beech, and maple which has presented an obstacle that has successfully challenged the ingenuity of pulp manufacturers ever since the invention of the groundwood process. The solution of this problem was one of the major objectives of the hardwood pulping project.

Exploratory Research

The exploratory research program was undertaken to determine the general effect of various types of wood pretreatments on the quality of the mechanical pulps which might be produced from hardwoods. A fundamental research project (*15*) had already proved that it was possible to completely penetrate wood blocks with salt-bearing liquors but these data furnished no information concerning the effect of such penetration on the groundwood pulps which might be manufactured from the treated woods.

Table III. Physical Characteristics of Some Woody Tissues (*16*)

Species	Length, mm.		Volume, %			Density[a], lb./cu. ft.
	Fiber	Vessel	Fiber	Vessel	Rays	
Spruce (*Picea glauca* Voss)	3.1–3.3[b]	.....	93[b]	..	6	25.0
Aspen (*Populus tremuloides* L.)	0.74–1.3	0.45–0.71	53	33	14	22.6
Birch (*Betula lutea* Michx.)	1.15–1.4	0.74–1.18	66	21	11	35.5
Beech (*Fagus grandifolia* Ehrh.)	1.07–1.42	0.51–0.66	..	..	20	35.0
Maple (*Acer saccharum* Marsh)	0.71–0.78	0.30–0.34	61	21	18	35.6

[a] Oven-dry weight/wet volume.
[b] Tracheids.

Equipment Employed and its Operation

Chemical Pulp Digester. The chemical pulp digester which was used for the wood pretreatments has a capacity of 65 cubic feet and is fabricated of stainless steel (KA2SMo) to resist corrosion. This digester and its accessory equipment are shown in Figure 1. Two liquor make-up tanks of similar composition and capacity are also a part of this system. The digester was designed for an operating pressure of 250 p.s.i. and a centrifugal pump capable of producing hydraulic pressures up to 300 p.s.i. is connected to the digester. The system is also equipped with a vacuum pump which may be employed when desired to draw a vacuum of 26 to 28 inches of mercury in 10 minutes. The digester is equipped with an outside heat exchanger and liquor circulating pump assuring good circulation and uniform distribution of heat and liquor. A complete automatic control system is provided for the digester with a time-cycle temperature controller for admitting steam to the heat exchanger, and a time-cycle pressure controller is connected to an automatic relief valve. A steam flow meter is provided to record the amount and rate of steam consumption in the digester. In addition, a multiple recording potentiometer has been installed to give a record of the temperature at six different points in the digestion system.

In utilizing this equipment in pretreating wood, the blocks, either in 24-inch or 48-inch lengths, were lowered vertically into the digester by means of a hoist located directly over the head of the digester. About 20 4-foot blocks averaging 8 inches in diameter could be accommodated in a single charge. Frequently five blocks of four different woods were treated simultaneously so that comparative evaluation tests could be made to determine how different woods reacted to identical treating conditions. After the digester was filled with the wood blocks, the cover was bolted down and the digester evacuated for a period of about 30 minutes. Liquor of any desired composition was then admitted into the evacuated digester and steam admitted to the heat exchanger to secure the desired temperature, e.g., 140°C. The pressure pump was then started and the pressure raised to any predetermined level, e.g., 200 p.s.i., by pumping cooking liquors into the digester. These conditions were maintained for the desired period of time, e.g., 6 hours, and the free liquor then blown into a tank and retained for the next cook. The treated logs were immediately removed from the digester by means of a hoist and rope. The logs were sawn to the proper length for grinding, i.e., 8 inches, and the volume of the blocks was determined by displacing water in a tank after which the blocks were withdrawn from the tank and ground into pulp.

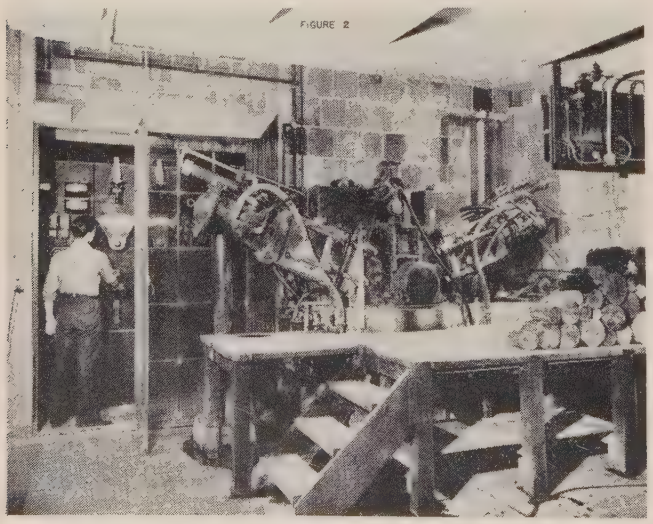


Fig. 2. Wood pulp grinder

Wood Pulp Grinder. The wood pulp grinder employed in this project was a small Great Northern type having two short exterior magazines each connecting with a wood pocket directly underneath and separated by a hydraulically operated slide (Fig. 2). This grinder takes a stone 32 inches in diameter with an 11-inch face, and has a nominal capacity of approximately 1 ton of spruce pulp per day. The grinder is powered by a 250 hp. d.-c. motor, with a speed adjustment from 300 to 900 r.p.m. corresponding to a stone peripheral speed of from 2500 to 7500 f.p.m. The area of each pocket of this grinder is 112 sq. in. (8 by 14-inches) and bolts of wood 8 inches long and 14 inches in diameter may be ground. This feature of design assists in giving a close correspondence of results with those of commercial grinders. A complete set of automatic control and recording instruments is provided for the grinder giving full control over the pit temperature, shower water temperature, grinding pressure, and grinding speed. Owing to the importance of accurate power readings for the woods ground during this project, these data were obtained by use of a Sangamo integrating watthour meter. This information, supplemented by other data which were recorded for each run, was then utilized in the calculation of specific evaluation factors as follows:

$$\text{Tons per day} = \frac{\text{Pounds of wood ground} \times 24}{\text{Time of run in hours} \times 2000}$$

$$\text{Tons per square foot per day} = \frac{\text{Tons per day}}{\text{Pocket area in square feet}}$$

$$\text{Horsepower} = \frac{\text{Kilowatt hours}}{\text{Length of run in hours} \times 0.746}$$

$$\text{Horsepower days per ton} = \frac{\text{Horsepower}}{\text{Tons per day.}}$$

It should be noted that all wood densities were calculated according to the method recommended by the United States Forest Products Laboratory. The freeness of pulp has been reported in Canadian Standard units and all pulp strength values were determined according to the standard test methods of TAPPI, except that the basis weight of all test sheets manufactured was 100 pounds (25 × 40—500). The burst and tear factors are reported as points per pound and grams per pound, respectively. These factors are calculated as follows:

$$\text{Burst factor} = \frac{\text{Bursting strength (pounds per square inch)}}{\text{Basis weight (25} \times \text{40–500)}}$$

$$\text{Tear factor} = \frac{\text{Tearing strength (grams)}}{\text{Basis weight (25} \times \text{40–500)}}$$

Grinding of Untreated Wood. In order to establish a base for the evaluation of the results of this research sample lots of the various species of hardwoods were ground prior to any chemical pretreatment, using commercial operating conditions, and the pulps manufactured were subjected to the usual quality evaluation tests. A comparison of the common strength values of

Table IV. Comparison of Commercial and Laboratory Prepared Spruce Groundwood Pulps with Untreated Hardwood Groundwood Pulps

Pulp sample, No.	Grinder Data: Power, hp. days per ton	Grinder Data: Production rate, tons per sq. ft. per day	Pulp qualities: Freeness C. S., ml.	Factors: Burst pt./lb.	Factors: Tear g./lb.	Factors: Bulk	Classification: Retained 20-mesh, %	Classification: Intermediates, %	Brightness
Commercial Spruce Pulps									
1	..	..	77	0.22	0.46	2.61	2.4	55.2	56.2
2	..	..	164	0.22	0.58	2.81	7.3	59.4	56.4
3	..	..	68	0.31	0.58	2.34	2.9	45.1	51.4
4	78	0.6	30	0.36	0.70	2.21	8.4	50.1	55.0
5	..	..	71	0.24	0.52	2.68	3.7	50.9	56.6
6	70	1.8	97	0.21	0.51	2.72	5.1	47.4	54.2
7	61	0.9	130	0.18	0.48	2.67	2.8	54.7	56.7
Ave.	70	1.1	91	0.25	0.55	2.58	4.7	53.3	55.2
Laboratory Spruce Pulps									
SR1	54	1.7	56	0.27	0.46	2.13	1.0	46.7	62.9
SR2	59	1.5	35	0.30	0.50	2.14	1.9	43.8	..
SR6	..	1.3	47	0.33	0.57	2.40	4.5	42.5	61.0
SR7	65	1.6	69	0.28	0.54	2.10	7.5	44.7	61.5
Ave.	59	1.5	52	0.30	0.52	2.19	3.7	44.4	61.8
Laboratory Untreated Hardwood Pulps									
Aspen PR6	75	1.2	114	0.22	0.60	2.24	4.6	53.8	60.5
Birch BiR15	69	2.4	76	0.05	0.18	2.37	1.2	26.8	54.1
Beech BeR10	67	2.7	54	0.04	0.14	2.64	0.4	14.7	42.8
Maple MR1	49	2.6	70	0.05	0.25	3.04	0.4	35.3	56.7

these pulps and an average of seven spruce pulps manufactured by ESPRA mills is shown in Table IV and presented graphically in Figs. 3, 4, and 5.

An inspection of these data indicates that aspen wood produces mechanical pulps only slightly lower in strength value than spruce but the burst and tearing strength qualities of the pulps produced from untreated birch, beech, and maple is less than 25% of that of normal spruce.

Grinding of Treated Wood. It has already been indicated that the literature of papermaking has numerous references to processes for pretreating wood before grinding. These reports as well as the experience of

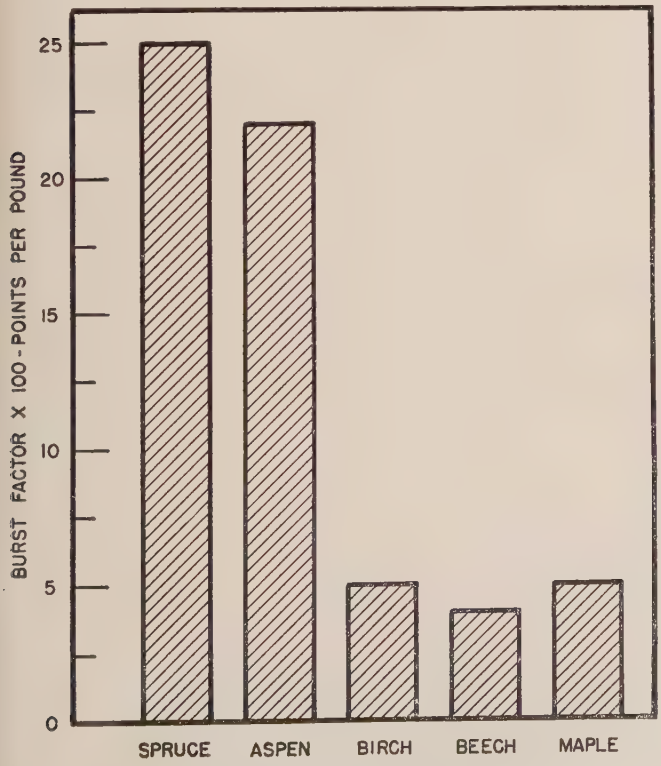


Fig. 3. Comparative bursting-strength values of mechanical pulps manufactured from untreated woods

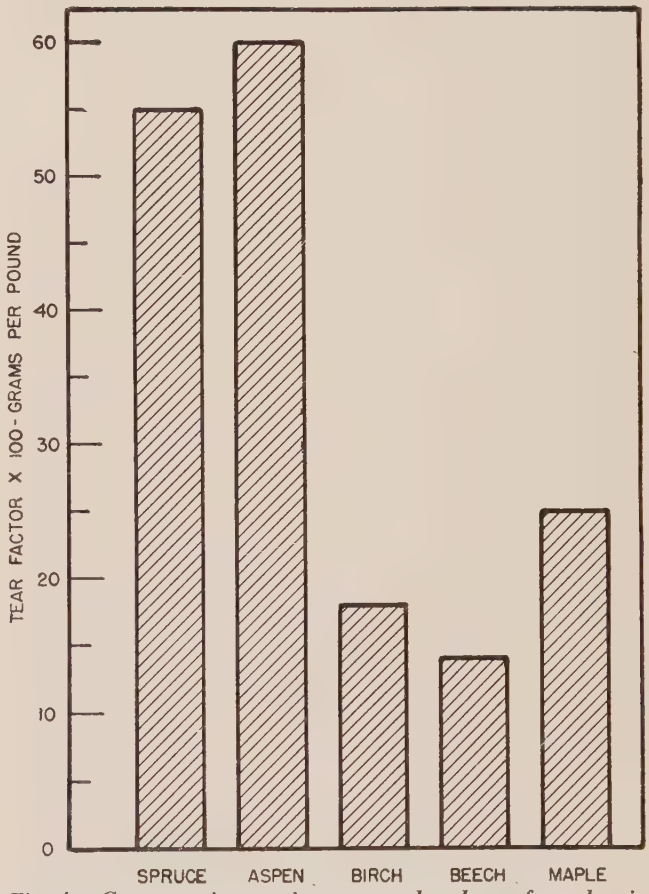


Fig. 4. Comparative tearing-strength values of mechanical pulps manufactured from untreated woods

the college staff on several similar projects prior to the establishment of the ESPRA program led to early investigation of wood pretreatments as a means of overcoming the natural defects of hardwoods as potential sources of satisfactory groundwood pulps. It should be mentioned that other possibilities were investigated also, particularly grinding wheel composition and preparation of the grinding surface of the different pulp

TABLE V. Effect of Liquor Concentration on Power Requirement and Physical Properties of Neutral Sulphite Treated Aspen Pulps

Cook No.	Wood length, in.	Treating liquor conc., lb./gal.	Grinder data: hp. days per ton	Grinder data: tons/sq. ft. per day	Pulp qualities: Freeness C. S., ml.	Pulp qualities: Factors: Burst, pt./lb.	Pulp qualities: Factors: Tear, g./lb.	Pulp qualities: Classification Retained by 20-mesh, %	Pulp qualities: Int., %	Pulp qualities: Brightness
106	24	0.50	28.4	2.9	449	0.33	0.81	5.8	76.3	38.2
81	24	1.00	30.9	2.1	155	1.04	0.85	8.7	69.6	36.1
82	24	1.25	39.0	1.8	141	0.96	0.82	6.4	67.5	32.4
83	24	1.50	33.8	2.2	115	0.95	0.77	5.3	71.9	35.2
109	24	1.60	33.1	2.5	182	0.79	0.81	4.6	72.0	37.4
108[a]	24	1.85	36.8	2.2	227	0.75	0.95	9.1	66.6	42.0
121	48	0.75	31.5	2.9	251	0.86	0.93	5.0	75.4	41.8
67	48	1.25	43.8	1.6	148	1.09	0.93	8.5	68.6	39.8
131	48	1.50	31.9	2.4	48	1.15	0.82	6.7	70.8	30.5

Digester Conditions
26 28 inches vacuum, 30 minutes
Treating liquor
Chemical ratio, 6/1 $Na_2SO_3/NaHCO_3$ as Na_2CO_3
[a] 4/1 $Na_2SO_3/NaHCO_3$ as Na_2CO_3
Total pressure, 150 p.s.i.
Treating time, 6 hours at 140°C.
Grinding Conditions
Pit temperature, 130°F.
Pocket pressure, 40 p.s.i.

stones employed. Neither of these factors or other variables studied, however, proved to be nearly as significant as the type and conditions of the chemical pretreatments to which the several woods were subjected.

Liquors of varying chemical composition were employed. The physical qualities of the mechanical pulps produced from logs treated with neutral sulphite liquors prior to grinding were satisfactory in most desirable characteristics and this paper is concerned only with this phase of the investigation. A more comprehensive presentation of these researches as well as the results of the tests made with other types of liquor will become available at an early date in a bulletin to be published by The New York State College of Forestry.

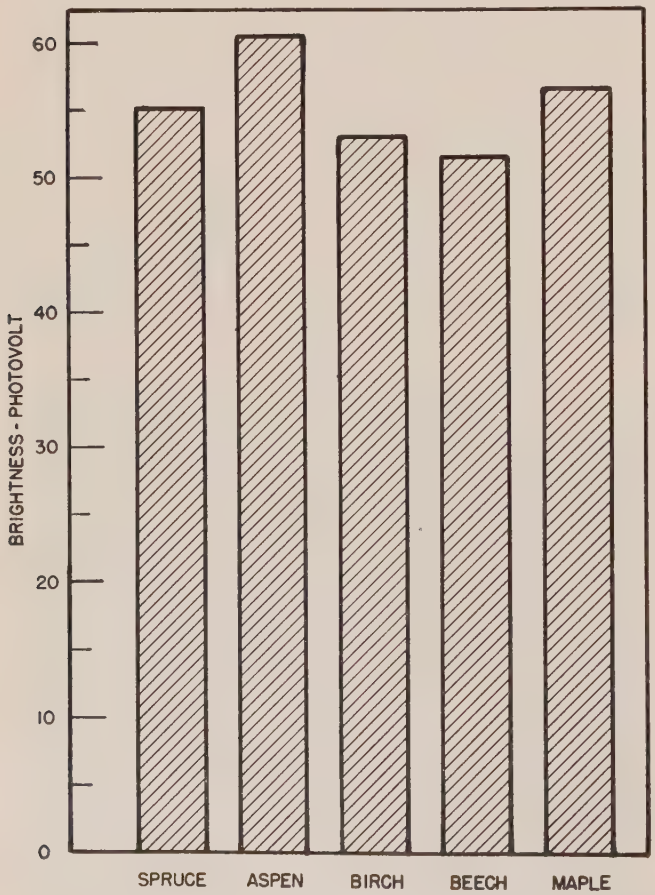


Fig. 5. Comparative brightness values of mechanical pulps manufactured from untreated woods

DEVELOPMENT OF THE CHEMIGROUNDWOOD PROCESS FOR HARDWOOD MECHANICAL PULP MANUFACTURE

The favorable results obtained with the neutral sulphite process in the exploratory investigation indicated that further work should be done in developing a better operating technique for the application of this method to hardwood pulping. No systematic work had been done to establish the optimum conditions for securing maximum penetration of the treating liquors into wood or for determining the extent of this penetration. The important factors of pulp quality, power consumption and rate of production, in comparison with the conventional spruce groundwood process, had not been thoroughly investigated. The relatively low brightness of the pulp produced from the chemically pretreated wood was a serious handicap to its utilization and obviously required improvement before the process could be considered a success. A comprehensive program of research designed to cover the major problems encountered in the exploratory investigation was therefore undertaken.

Outline of Pilot Plant Research

The major part of the research which was undertaken in the development of the chemigroundwood process was done on a pilot plant scale. Both natural and process variables were investigated.

Wood

Species Investigated. In order to establish reference standards for evaluating the results of the hardwood pulping research, several lots of spruce wood were ground in the Great Northern laboratory grinder using both natural and artificial stones. The results of four of these runs are summarized in Table IV. A further basis for comparison was obtained by making complete evaluation tests on samples of spruce groundwood pulp submitted by seven member mills (Table IV, Figs. 3, 4, and 5). It is apparent that there is little difference between the quality of pulps manufactured commercially and those prepared on the experimental grinder. The inferior quality of the untreated hardwood pulps when compared with normal spruce pulp is also obvious.

Log Dimensions. Considerable work was done during the course of this research to determine if it was possible to impregnate 48-inch blocks of wood sufficiently to permit satisfactory pulping. The initial work on wood impregnation with neutral sulphite liquors was done on

Table VI. Effect of Chemical Ratio on Power Consumption and Physical Properties of Chemigroundwood Birch Pulps

Cook No.	Treating liquor chemical ratio $Na_2SO_3/NaHCO_3$	Grinder data: hp. days per ton	Grinder data: tons/sq. ft. per day	Pulp Qualities: Freeness C. S., ml.	Pulp Qualities: Factors: Burst, pt./lb.	Pulp Qualities: Factors: Tear g./lb.	Pulp Qualities: Classification Retained by 20-mesh, %	Pulp Qualities: Classification Int., %	Pulp Qualities: Brightness
24	1.1 to 1	41.8	2.4	200	0.47	0.82	3 2	54.2	24.6
23	1.9 to 1	40.7	2.2	252	0.43	0.59	4.0	63.0	32.6
20	3.9 to 1	35.5	2.6	230	0.34	0.59	3.4	61.2	34.7
25	6.0 to 1	39.0	2.0	195	0.70	1.00	6.0	59.6	34.9
22	8.6 to 1	32.8	2.5	238	0.54	0.86	6.0	65.4	39.1
26	9.9 to 1	35.4	2.7	198	0.53	0.92	4.8	63.6	39.0

Data developed from treated 24-in. logs
Digester Conditions
Treating time, 6 hours at 140°C.
Treating pressure, 50 p.s.i.
Liquor Concentration 1 lb./gal.
Grinding Conditions
Pit temperature, 130°F.
Pocket pressure, 40 p.s.i.

24-inch wood. Table 5, Fig. 6 shows the relation between chemical concentration in the treating liquors and wood length with regard to securing equal impregnation in logs of different length. It was not found necessary to change any condition except liquor strength to secure equally good impregnation in long and short blocks, the pulp quality from blocks of both dimensions being equally good.

Pretreatment Conditions

Type of Liquor. All of the common types of treating liquor were employed in this research. Alkaline liquors of the types used in both the soda and kraft pulp industries were investigated and considerable improvement in pulp strength was secured with both these liquors. However, there was severe deterioration in the color of the pulps produced and it was obvious that these pulps could never be bleached economically for use in white papers. Acid liquors similar to those used in the sulphite pulp industry, but weaker in strength, were also employed with good success insofar as strength improvement in the pulps was concerned. The acid treatment also produced pulps of rather low brightness and the corrosive nature of the process made it of very doubtful commercial interest because of the large investment in acid-resisting equipment which would be required. Optimum results in both pulp strengths and brightness were obtained with the use of neutral sulphite liquors which were prepared by dissolving technical sodium sulphite (Na_2SO_3) in water and adjusting to the desired chemical ratio by the further addition of sodium bicarbonate ($NaHCO_3$). Figure 7 presents graphically the essential information on pulp brightness obtained with the different types of cooking liquors which led to the decision to concentrate on the use of neutral sulphite liquors in this research.

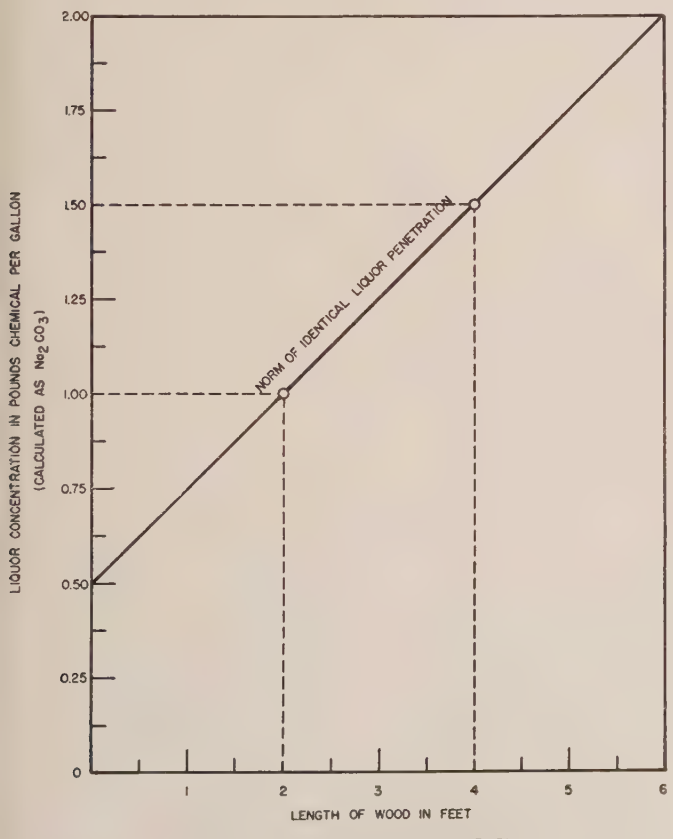


Fig. 6. Nomograph indicating required liquor concentration for equal impregnation of varying log lengths under standard treating conditions

Liquor Composition. The organic acids formed by hydrolysis during the course of a cook with neutral sodium sulphite make it necessary to have sufficient alkali present to partially neutralize these acids to prevent darkening of the wood caused by acid hydrolysis. Sodium bicarbonate ($NaHCO_3$) has been found to be the most desirable alkali to employ for this purpose. Soda ash (Na_2CO_3) might be employed but it is a stronger alkali and there is danger of reducing pulp brightness because of its alkaline reaction on the wood. Furthermore, bicarbonate has a stronger buffering action than normal carbonate and consequently stabilizes pH conditions during the cook at a point nearer neutrality than does soda ash. If the cooking liquors are prepared by gassing soda ash solutions with sulphur dioxide (SO_2) the resulting products are a mixture of sodium sulphite and sodium bicarbonate and the strength of the solutions may be adjusted so that the end products are in the correct proportion for the cook. Determination of these proportions was the subject of an extensive study during this investigation and a few of the significant results on the bursting strength

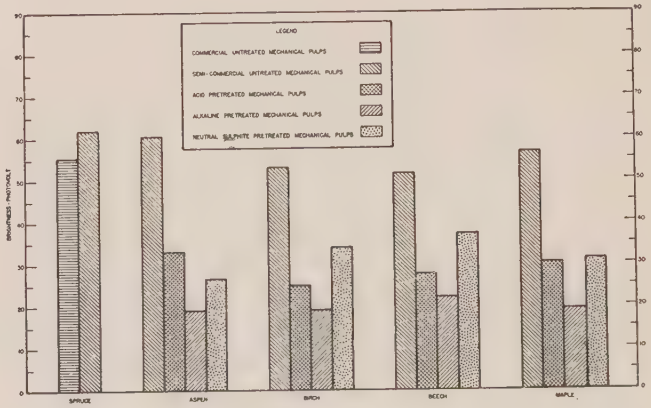


Fig. 7. Effect of chemical pretreatments on the brightness of mechanical pulps from hardwoods

Table VII. Effect of Digester Pre-evacuation on Power Requirements and Physical Properties of Birch Chemigroundwood Pulps

Treating conditions							Pulp Qualities					
		Vacuum			Grinder data			Factors		Classification		
Cook No.	Wood length, in.	Time, hr.	In.	Treating liquor conc., lb./gal.	hp. days per ton	tons/sq. ft. per day	Freeness C. S. ml.	Burst, pt./lb.	Tear, g./lb.	Retained by 20-mesh, %	Int., %	Brightness
115	48	0.5	26	1.50	31.1	3.3	212	0.43	0.98	13.3	57.5	49.2
117	48	1.0	26	1.50	36.1	2.8	217	0.35	0.81	7.4	60.4	57.1
118	48	2.0	26	1.50	39.0	2.6	235	0.44	1.00	14.7	55.1	57.6
81	24	0.5	26	1.00	31.2	2.8	249	0.57	0.94	9.5	58.6	49.0
89	24	6.0	26	1.00	44.8	2.5	231	0.57	0.83	11.0	56.4	49.6
86	24	18.0	26	1.00	32.9	3.0	313	0.71	1.11	18.8	53.9	53.4

Digester Conditions
Treating time, 6 hours at 140°C.
Total pressure, 150 p.s.i.
Treating liquor
Chemical ratio, 6/1 $Na_2SO_3/NaHCO_3$ as Na_2CO_3
Grinding Conditions
Pit temperature, 130°F.
Pocket pressure, 40 p.s.i.

values of the resulting pulps are presented in Table 6, Fig. 8.

An analysis of the data developed by this phase of the investigation leads to the conclusion that the physical properties of pulps manufactured from wood treated with liquors having a chemical ratio of 6 to 1 have optimum strength properties. Increasing the sulphite component of the treating liquors to a ratio of 10 to 1 results in a decrease in the power consumption and

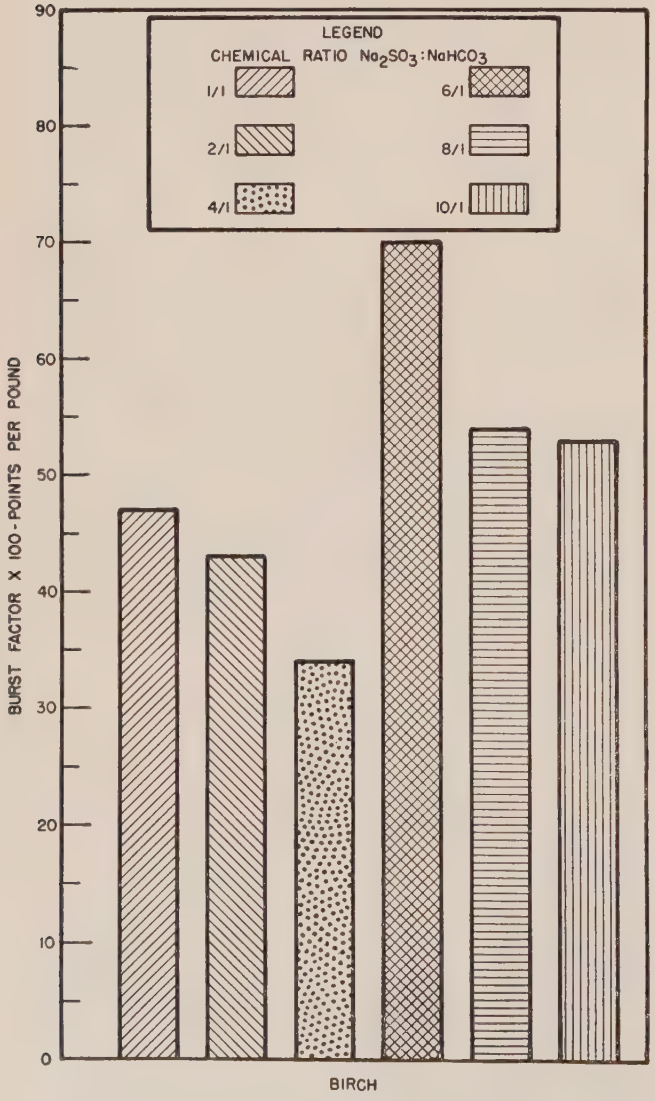


Fig. 8. Effect of chemical ratio on bursting strength in grinding treated hardwoods

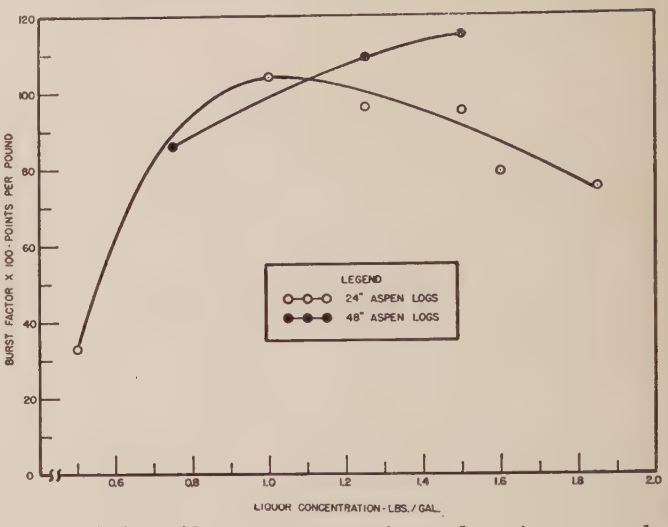


Fig. 9. Effect of liquor concentration on bursting strength

physical strength properties and an increase in the brightness of the resulting pulps. These data would seem to indicate that the ratio of the chemical components of the liquor is not critical. However, since an important objective of this research was to develop pulps with good strength characteristics, it was decided to employ liquors having a chemical ratio of 6 parts sulphite to 1 part bicarbonate during the remainder of this project. Using the optimum ratio of 6 to 1, the pH of the cooking liquor at the beginning of the cook is about 9.5 and this decreases to pH 9.3 at the end of a 6-hour treating period.

Considerable work was done to determine the optimum concentration of chemical in the cooking liquor to produce pulps of maximum strength. Liquors varying in concentration from 0.35 to 1.86 pounds per gallon of mixed chemicals (calculated as Na_2CO_3) were employed in cooking the 24-inch blocks of wood under investigation (Table V, Fig. 9).

It is apparent that a concentration of 1.0 pound per gallon is sufficient to give a maximum burst test on pulp manufactured from the 24-inch aspen blocks treated either with or without vacuum and hydrostatic pressure during the digestion period. Further work developed the fact that a concentration of 1.5 pounds per gallon gave similar results with 48-inch wood blocks.

The percentage of chemical consumed on the oven-dry weight of raw wood amounted to approximately 10.0% in the best cooks. The unused portion of the chemical added to the digester remained in the liquor and it was found entirely feasible to reuse this liquor indefinitely by merely fortifying it with new chemical equivalent to the amount which had been consumed. While the color of the used liquor was dark, reuse did not reduce the brightness of the pulps from successive

Table VIII. Effect of Vacuum and Hydrostatic Pressure on Power Requirements and Physical Properties of Chemigroundwood Pulps

Cook No.	Wood species	Length wood, in.	Treating conditions: Vacuum in.	Total pressure, p.s.i.	Liquor conc., lb./gal.	Grinding conditions: hp. days per ton	tons/ sq. ft. per day	Pulp qualities: Freeness C. S. ml.	Factors: Burst, pt./lb.	Tear, g./lb.	Classification: Retained by 20-mesh, %	Int., %	Brightness
34	Aspen	24	0	50	1.00	37.2	1.8	91	0.79	0.80	4.5	65.5	26.5
32	Birch	24	0	50	1.00	37.5	2.2	173	0.64	0.82	5.1	62.2	33.7
31	Beech	24	0	50	1.00	30.6	2.5	265	0.24	0.55	1.2	60.0	36.9
81	Aspen	24	26	200	1.00	30.9	2.1	155	1.04	0.85	8.7	69.6	36.1
81	Birch	24	26	200	1.00	27.6	2.7	228	0.65	1.04	13.2	57.3	48.0
81	Beech	24	26	200	1.00	20.8	3.5	255	0.22	0.53	1.6	54.6	45.2

Digester conditions for treating 24-in. wood
Time, 6 hr. at 140°C.
Chemical ratio, 6/1 $Na_2CO_3/NaHCO_3$ as Na_2CO_3
Liquor concentration, 1.0 lb. gal. as Na_2CO_3
Grinding Conditions
Pit temperature, 130°F.
Pocket pressure, 40 p.s.i.

cooks to any appreciable extent. The ability to continually reuse the treating liquors in successive cooks amounts to a chemical recovery of 80 to 85% and would be an important factor in establishing the process on a commercial basis without the necessity of a large investment in chemical recovery equipment.

Digester Evacuation. Evacuation of air from the digester was undertaken early in the investigation as it had been proved by the small scale research (*15*) that this procedure facilitated penetration of the liquor into the wood blocks. A considerable number of cooks were completed during the study of this variable in which the time of evacuation was varied from 30 minutes to 18 hours, a vacuum of 26 inches of mercury being maintained on the digester system throughout this period. It was found that very little advantage was gained by subjecting the wood blocks to a vacuum of more than 30 minutes duration and this period of 30 minutes was therefore adopted as standard throughout the remainder of this research. The effect of the varying periods of vacuum treatment on the physical properties of several different pulps is shown in Table VII, Fig. 10.

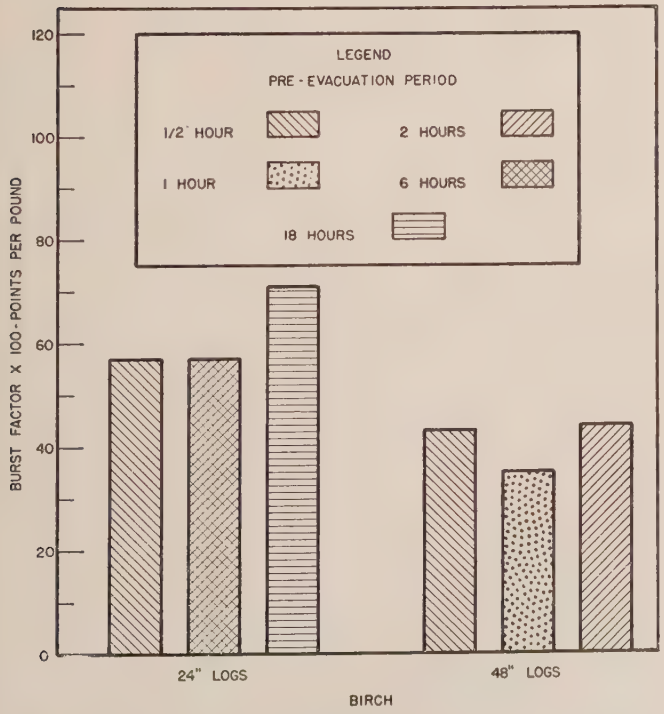


Fig. 10. Effect of digester pre-evacuation on bursting strength

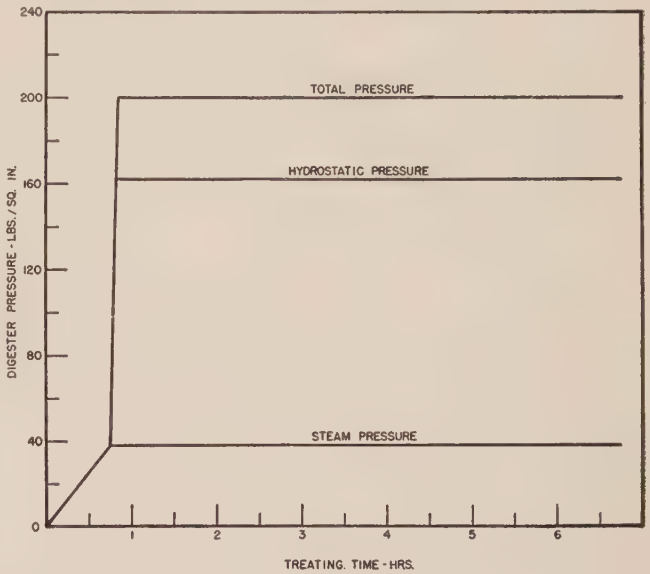


Fig. 11. Distribution of pressure effects during treating cycle

Digester Pressure. The use of elevated pressures during wood treatment in the digester was also investigated and the results of the small scale experiments have already been described (*15*). The cumulative effect of vacuum and pressure was a subject on which considerable work was done both on a small scale and in the pilot plant. Increased penetration of the wood blocks by the cooking liquor was obtained in this manner and pulps of improved quality were produced. The elevated pressures were obtained hydrostatically by the use of a pump and varying pressures up to 200 p.s.i. were investigated. The distribution of pressure between steam and hydraulic is shown in Fig. 11. The results of this study led to the adoption of a total pressure of 200 p.s.i. as being most practical for commerical applications of this procedure. In general, improvement in power requirements, physical properties, and brightness because of the use of the vacuum-pressure treatment were noted (Table VIII Fig. 12).

Pretreatment Temperatures. Experiments were conducted throughout the course of this investigation to determine the optimum temperature at which the pretreatments should be conducted. Cooks were made at temperatures varying from 120 to 170°C. When the cooks were conducted for 6 hours at 120°C. the resulting pulps were not appreciably better than those manufactured from raw wood. Pulps made at 170°C. were distinctly darker in color as a result of burning of the heartwood area although the strength properties were not seriously affected. As a result of this series of runs it was decided that 150°C. was the most generally acceptable temperature although almost equally good

Table IX. Effect of Treating Temperature on Power Requirements and Physical Properties of Chemigroundwood Pulps

Cook No.	Wood	Treating temp., °C.	Grinder data: hp. days per ton	Grinder data: tons/ sq. ft. per day	Pulp qualities: Freeness C. S., ml.	Pulp qualities: Factors: Burst, pt./lb.	Pulp qualities: Factors: Tear, g./lb.	Pulp qualities: Classification: Retained by 20-mesh, %	Pulp qualities: Classification: Int., %	Pulp qualities: Brightness
108[a]	Aspen	130	36.8	2.2	227	0.75	0.95	9.1	66.6	42
115	Aspen	140	32.0	2.9	210	0.76	0.95	4.1	73.4	32.2
131	Aspen	150	31.9	2.4	48	1.15	0.82	6.7	70.8	30.5
125	Aspen	160	23.3	2.9	88	0.89	0.96	7.0	71.1	20.5
108[a]	Birch	130	37.5	2.6	384	0.23	0.77	9.2	61.2	52.4
115	Birch	140	31.1	3.3	212	0.43	0.98	13.3	57.5	49.2
131	Birch	150	42.9	2.5	92	0.89	1.13	25.7	45.9	42.8
125	Birch	160	29.4	2.6	47	0.78	0.99	31.8	42.5	23.5
108[a]	Beech	130	26.9	3.6	344	0.19	0.51	2.1	58.6	44.9
115	Beech	140	28.2	4.1	271	0.15	0.51	1.3	56.1	37.1
131	Beech	150	30.3	3.2	100	0.44	0.74	8.8	55.4	37.0
125	Beech	160	24.8	3.2	121	0.36	0.78	2.0	58.1	30.3

Digester conditions for treating 48-in. wood
Treating liquor
Concentration, 1.5 lb./gal. (Na_2CO_3)
Chemical ratio, 6/1 $Na_2SO_3/NaHCO_3$ as Na_2CO_3
Treating Conditions
Vacuum 26 in. for 30 min.
6 hr. at temperature
Total pressure, 150 p.s.i.
Grinder Conditions
Pit temperature, 130°F.
Pocket pressure, 40 p.s.i.
[a] 24-in. blocks.

results could be obtained by similar treatments at slightly lower temperatures, e.g., 6 or 7 hours at 140°C. (Table X). The effect of the treating temperature on the burst factor of pulps made with a 6-hour wood pretreatment is shown in Table IX, Fig. 13.

Time of Pretreatment. As a result of an exhaustive study of pretreatment times it was concluded that a cooking period of 6 hours gave optimum results in most cases, employing the other standard conditions described in this report. The range of treating periods investigated varied from 2 to 10 hours. It should be understood that 6-hour treatments do not always give maximum tests in every pulp quality but the average test for most pulps is optimum for this period of treatment (Table X, Fig. 14).

Pulping Conditions

Type of Stone. Both natural and artificial stones were employed in this investigation. The natural stone was a Lombard resin impregnated stone and the Norton and Carborundum artificial stones contained abrasive particles of aluminum oxide grit. A new type induced pore Norton stone[1] was used with good results while a similar stone manufactured by the Carborundum Co.[2] and known as an open pore stone was also used successfully. Considering the wide difference in the composition of the natural and artificial stones and the high quality of the pulps made on both types of stones, it was concluded that the type of stone employed for the manufacture of chemigroundwood pulps was of relative unimportance compared with other factors encountered, especially the quality of the wood, and variables in the pretreatment and pulping phases of the process.

[1] Norton Co., 38 Alundum, Grit 60, No. 38A6012N10VP.
[2] Carborundum Co., Open Pore, Grit 63, No. GA63C6L7V10.

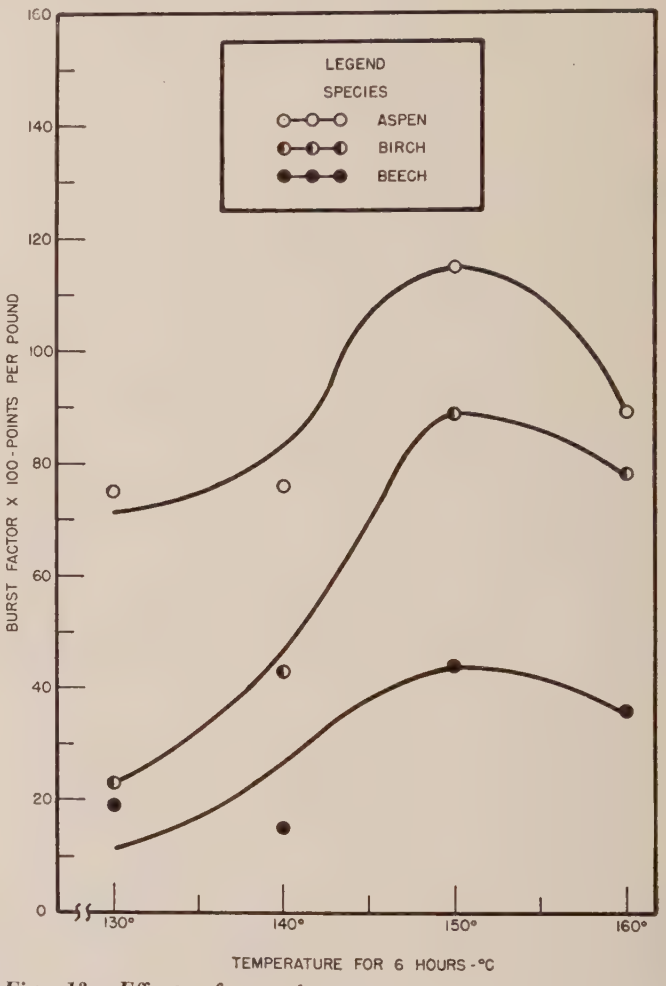


Fig. 13. Effect of treating temperature on bursting strength

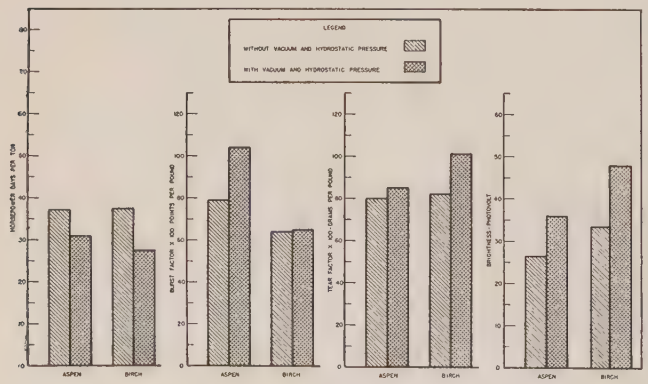


Fig. 12. Effect of vacuum and hydrostatic pressure on power requirements and physical properties of chemigroundwood pulps

Preparation of Stone Face. Some work was done during the course of this research concerning the effect of different grinding surfaces on pulp quality and the power requirements of the pulping process. Both natural and artificial stones were dressed with several types of burrs including diamond, thread, and spiral burrs of different cuts and leads. Results led to the conclusion that a No. 9 by $1^1/_2$ spiral burr gave the best over-all results. Maximum strength qualities

Table X. Effect of Treating Time on Power Requirements and Physical Properties of Chemigroundwood Pulps

Cook No.	Wood	Grinder data: Treating time, hr.	Grinder data: hp. days per ton	Grinder data: tons/sq. ft. per day	Pulp qualities: Freeness C. S. ml.	Pulp qualities: Factors: Burst, pt./lb.	Pulp qualities: Factors: Tear, g./lb.	Pulp qualities: Classification Retained by 20-mesh, %	Pulp qualities: Int., %	Pulp qualities: Brightness
136	Aspen	4	29.8	2.8	348	0.68	1.13	10.4	68.3	48.9
134	Aspen	5	30.6	2.5	74	1.12	0.73	11.1	65.3	42.5
131	Aspen	6	31.9	2.4	48	1.15	0.82	6.7	70.8	30.5
130	Aspen[a]	7	26.6	3.0	124	1.05	0.87	7.7	76.2	36.6
136	Birch	4	44.1	2.1	249	0.24	0.67	10.6	56.9	57.0
134	Birch	5	39.0	2.5	100	0.73	0.98	24.3	47.7	46.5
131	Birch	6	42.9	2.5	92	0.89	1.13	25.7	45.9	42.8
138	Birch	7	35.9	2.6	186	0.81	1.23	21.8	52.0	46.9
136	Beech	4	26.6	3.6	284	0.12	0.36	1.2	55.1	47.5
134	Beech	5	29.2	3.0	103	0.41	0.59	2.2	51.3	37.5
131	Beech	6	30.3	3.2	100	0.44	0.74	8.8	55.4	37.0
146	Beech	7	26.6	3.7	81	0.44	0.77	2.6	52.1	36.8

Digester conditions for treating 48-in. wood
Treating liquor
Chemical concentration, 1.5 lb./gal. as Na_2CO_3
Chemical ratio, 6/1 $Na_2SO_3/NaHCO_3$ as Na_2CO_3
Treating Conditions
Vacuum, 26 in. for 30 min.
Temperature, 150°C. [a] 140°C.
Total pressure, 150 p.s.i.
Grinding Conditions
Pit temperature, 130°F.
Pocket pressure, 40 p.s.i.

were produced when the surface of the stone was dull compared with the surface used for the manufacture of mechanical pulp from new spruce.

Stone Speed. Due to limitations in the physical strength of the stones used in the experimental grinder, the stone was operated at 400 r.p.m. which gave a peripheral speed of 3300 f.p.m. This corresponds very closely to the surface speed of many commercial grinders. It has been demonstrated that the general effect of increasing stone speed is to increase the rate

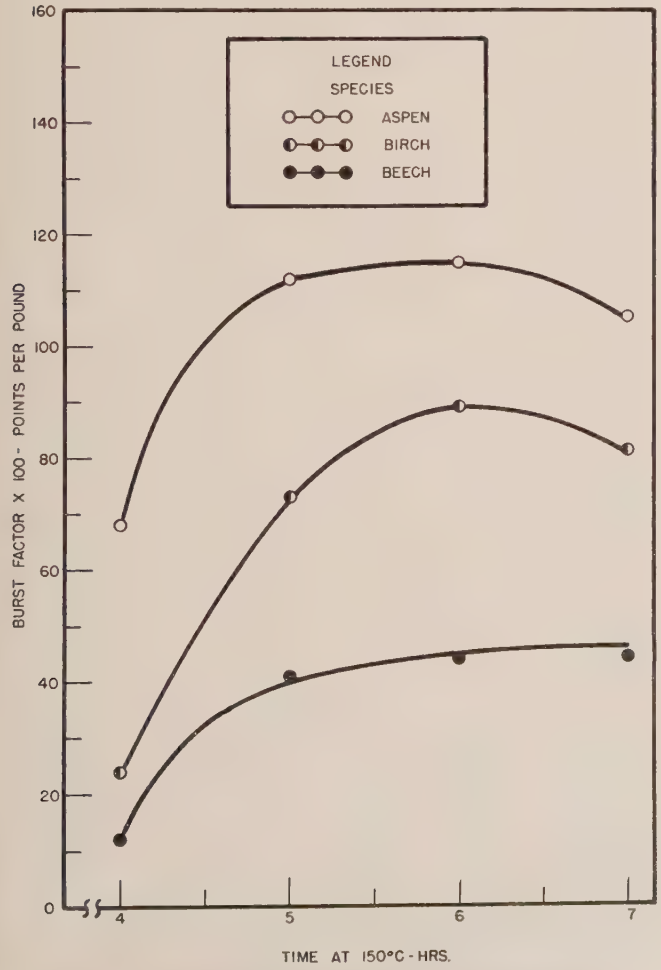


Fig. 14. Effect of treating time on bursting strength

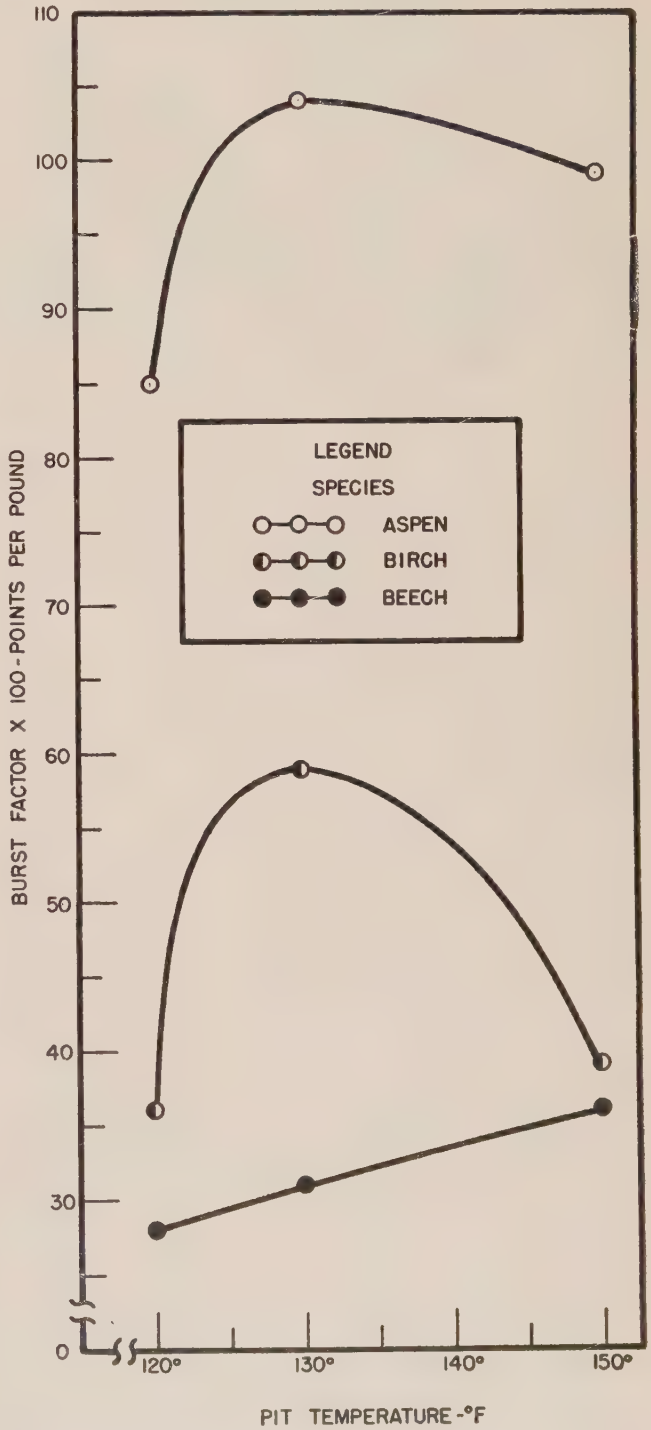


Fig. 15. Effect of pit temperature on bursting strength

Table XI. Effect of Pit Temperature on Power Requirements and Physical Properties of Chemigroundwood Pulps

Cook No.	Wood	Grinder data: hp. days per ton	Grinder data: tons/sq. ft. per day	Grinder data: Pit temp., °F.	Pulp qualities: Freeness C. S. ml.	Pulp qualities: Factors: Burst, pt./lb.	Pulp qualities: Factors: Tear, g./lb.	Pulp qualities: Classification Retained by 20-mesh, %	Pulp qualities: Int., %	Pulp qualities: Brightness
93	Aspen	42.8	1.8	120	111	0.85	0.78	4.7	71.3	36.3
88	Aspen	35.3	1.7	130	127	1.04	0.79	5.9	73.3	35.0
92	Aspen	34.4	1.9	150	150	0.99	0.77	7.0	72.4	36.9
93	Birch	37.9	2.1	120	219	0.36	0.73	6.9	57.9	50.3
88	Birch	35.6	2.4	130	155	0.59	0.76	5.9	58.0	46.1
92	Birch	38.9	2.5	150	300	0.39	0.74	11.3	60.0	52.6
93	Beech	29.2	2.7	120	137	0.28	0.52	1.0	52.1	39.3
88	Beech	27.8	3.9	130	302	0.31	0.67	1.7	62.0	39.8
92	Beech	26.6	3.3	150	267	0.36	0.65	1.0	57.8	42.5

Digester conditions based on treating 24-in. wood blocks
Treating liquor
Chemical concentration, 1.0 lb./gal. as Na_2CO_3
Chemical ratio, 6/1 $Na_2SO_3/NaHCO_3$ as Na_2CO_3
Treating Conditions
Vacuum, 26 in. for 30 minutes
Temperature, 140°C. for 6 hr.
Total pressure, 150 p.s.i.
Grinding Conditions
Pocket pressure, 40 p.s.i.

of production and to decrease pulp quality slightly. There is no reason to suppose that these factors would be altered in the case of chemigroundwood pulps.

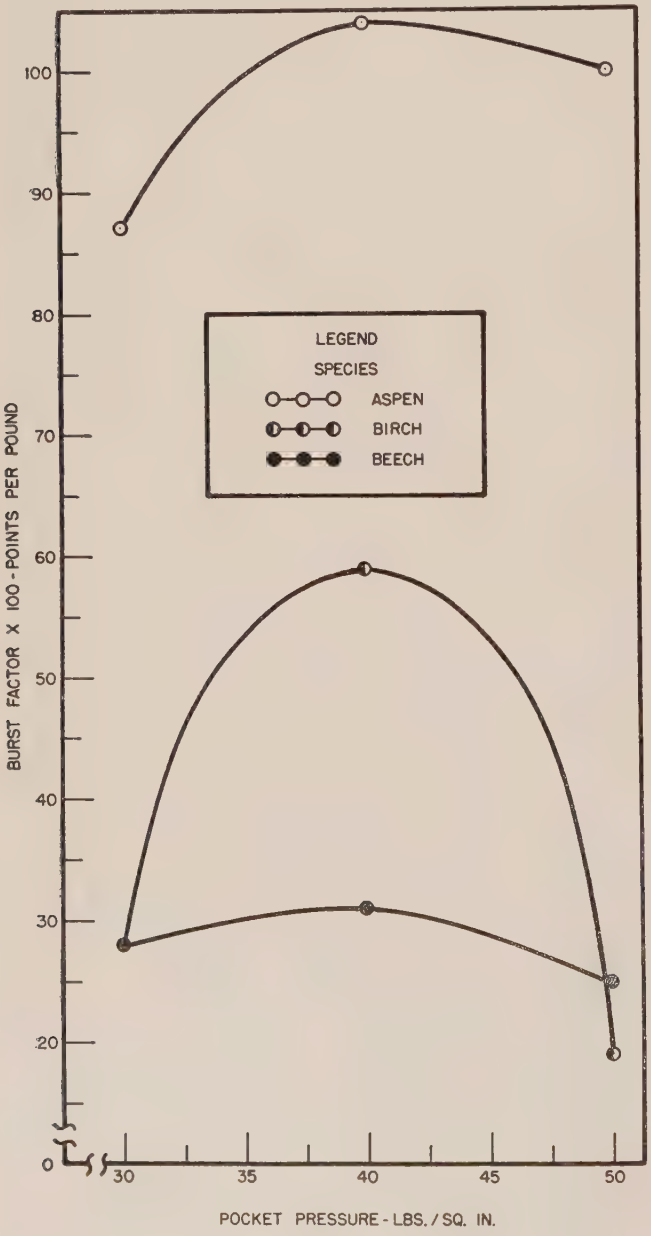


Fig. 16. Effect of pocket pressure on bursting strength

Grinder Pit Consistency. During the course of this research some observations were made to determine the effect of grinder pit consistency on the quality of the pulp manufactured. Consistencies varied between 4.5 and 6.0% during different grinder experiments with an average of about 5.0% generally prevailing. No effect on pulp quality that could be attributed directly to this variable were observed during these studies.

Grinder Pit Temperatures. The temperature of grinding as measured in the grinder pit appears to have considerable effect on the physical characteristics of the resulting pulp. Tests were conducted over a range of temperatures varying from 120 to 170°F. These studies proved that maximum strength values were obtained on pretreated woods at approximately 130°F. (Table XI, Fig. 15).

Pressure of Grinding. The pressure per unit area between wood and stone was investigated between the ranges of 30 and 50 p.s.i. In the case of the experimental grinder employed in this investigation this pressure corresponds almost exactly to the pocket pressure in pounds per square inch as shown by the recording gage connected to the hydraulic cylinders of the grinder. As the pocket pressure was increased from 30 to 40 p.s.i., production rate and physical strength properties of the pulps produced were greatly improved. Further elevation of the pocket pressure resulted in additional increases in the production rate but seriously deteriorated pulp quality, especially bursting strength. This effect is shown in Table XII, Fig. 16, and justifies the adoption of a pocket pressure of 40 p.s.i. which was the standard grinding pressure condition employed in this research.

Fiber Classification. Bauer-McNett fiber classification tests were made on all pulps manufactured by the chemigroundwood process as well as on the untreated hardwood mechanical pulps and commercial spruce mechanical pulps. These data are presented in the various tables in conjunction with the other physical properties of treated and untreated pulps and the average of some representative tests are summarized in Table XIII.

Inspection of these data indicates that the percentage intermediates, i.e., fiber retained on the 35, 65, and 150-mesh screens, are at least 10% greater for the chemigroundwood pulps than for the spruce mechanical pulps and over 40% higher than for the untreated dense hardwood pulps. The coarse fiber fraction, i.e., that fiber retained on the 20-mesh screen, is slightly higher for the chemigroundwood pulps, particularly aspen and birch, than for the commercial spruce pulps and very much higher than the test values for the untreated hardwood pulps.

Table XII. Effect of Pocket Pressure on Power Requirements and Physical Properties of Chemigroundwood Pulps

Cook No.	Wood	Grinder Data: hp. days per ton	Grinder Data: tons/sq. ft. per day	Grinder Data: Pocket pressure, p.s.i.	Pulp Qualities: Freeness C. S., ml.	Pulp Qualities: Factors: Burst, pt./lb.	Pulp Qualities: Factors: Tear, g./lb.	Pulp Qualities: Classification: Retained by 20 mesh, %	Pulp Qualities: Classification: Int., %	Pulp Qualities: Brightness
100	Aspen	34.4	1.7	30	200	0.87	0.95	7.9	70.9	39.0
88	Aspen	35.3	1.7	40	127	1.04	0.79	5.9	73.3	35.0
99	Aspen	40.0	2.2	50	107	1.00	0.83	6.5	69.4	33.0
100	Birch	38.5	2.0	30	234	0.28	0.77	7.0	62.2	49.2
88	Birch	35.6	2.4	40	173	0.59	0.76	5.9	58.0	46.1
99	Birch	32.2	3.3	50	246	0.19	0.58	5.3	60.8	49.4
100	Beech	26.0	2.5	30	262	0.28	0.62	2.0	60.1	41.2
88	Beech	27.8	3.9	40	302	0.31	0.67	1.7	62.0	40.0
99	Beech	25.3	3.4	50	278	0.25	0.62	1.6	60.3	44.2

Digester conditions based on treating 24-in. wood blocks
Treating Liquor
Chemical concentration, 1.0 lb./gal. as Na_2CO_3
Chemical ratio, 6/1 $Na_2SO_3/NaHCO_3$ as Na_2CO_3
Treating Conditions
Vacuum, 26 in. for 30 min.
Temperature, 140°C. for 6 hr.
Total pressure, 150 p.s.i.
Grinding Conditions
Pit temperature, 130°F.

The most uniform separation of the woody tissues effected by grinding the treated wood blocks is further exemplified by the photomicrographs (Fig. 17 through 21). These photomicrographs show a normal commercial spruce mechanical pulp (Fig. 17), pulps manufactured from untreated aspen and birch (Figs. 18, 19) and chemigroundwood aspen and birch pulps (Figs. 20, 21).

From the photomicrographs, it is apparent that the fibers of chemigroundwood pulps look more like unbleached hardwood sulphite pulp than like normal groundwood pulp. The characteristic fiber clumps and broken fibers found in commercial mechanical pulps are entirely missing and the fibers and vessels of chemigroundwood pulps are completely separated and apparently unbroken. Undoubtedly this unbroken condition of the tissues is responsible for the superior strength characteristic of the chemigroundwood pulps.

Use of Wetting Agents. Experimentation with a limited number of wetting agents was undertaken with the objective of securing more rapid and thorough penetration of the treating liquors into the wood blocks. The most favorable results were obtained with Triton X-100; a polyether alcohol classed as a nonionic surface active agent and manufactured by the Rohm and Haas Co. of Philadelphia, Pa. Equally good results were obtained by use of Solvadine R distributed by the Ciba Co., New York, N. Y. These two agents were added in sufficient quantities to the treating liquors to produce solutions of 0.05 and 0.075% concentration and the cooks were then carried out in the usual manner. On the weight of wood treated, this concentration of wetting agent amounted to 0.015 and 0.020%, respectively. Generally this technique was effective,

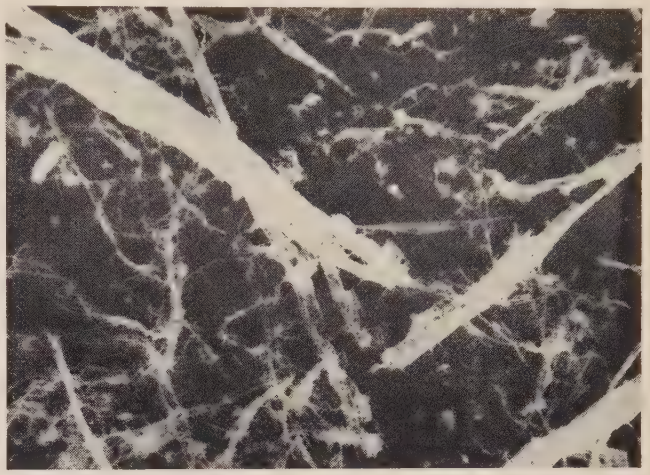


Fig. 17. Spruce mechanical pulp

especially with aspen and birch, in producing pulps with moderately increased bursting and tearing strengths and in the case of aspen with considerably increased brightness values (Table XIV, Fig. 22).

Insufficient work was completed on this phase of the pulping project to justify a conclusion that routine use of surface active agents is economically feasible and should be recommended. The interesting nature of the exploratory results, however, indicates that further work along these lines should be undertaken.

Storage of Treated Wood. A brief investigation was conducted to determine the effect of storing treated logs for varying periods of time before grinding. It was found that treated wood which had been stored 16 hours ground more rapidly and with as much as 5 hp. days per ton less power than wood ground immediately after treatment. Furthermore, in the case of birch and beech, strength values of the pulp made from this stored wood were nearly 20% better than those of pulps prepared from the freshly ground wood. Small additional savings in power and improvements in

Table XIII. Bauer-McNett Classification Tests

Wood species	Type of pretreatment	Pulp qualities: Freeness C. S., ml.	Pulp qualities: Burst, pt./lb.	Pulp qualities: Tear, g./lb.	Pulp qualities: Bulk	Classification: Retained by screen 20, %	35, %	65, %	150, %	Through 150, %	Int., %
Spruce	None	91	0.25	0.55	2.58	4.7	18.0	20.8	14.5	42.0	53.3
Hardwood	Soda	557	0.13	0.63	2.17	1.2	46.6	29.1	13.5	9.6	89.2
Aspen	...	147	0.20	0.42	2.32	3.2	14.8	21.1	19.2	41.7	55.1
Aspen	N.S.[a]	149	0.95	0.84	1.30	6.4	32.0	32.0	6.3	23.3	70.3
Birch	...	184	0.05	0.15	2.43	1.0	14.9	9.4	19.5	55.2	43.8
Birch	N.S.[a]	238	0.57	0.95	1.96	11.5	30.5	20.0	7.5	30.5	58.0
Beech	...	162	0.04	0.13	2.52	0.5	1.3	7.4	16.7	74.1	25.4
Beech	N.S.[a]	210	0.33	0.61	2.47	1.9	19.5	28.0	28.6	22.0	76.1
Maple	...	200	0.06	0.15	2.20	0.4	0.3	4.4	17.7	76.8	22.4
Maple	N.S.[a]	252	0.35	0.54	2.15	0.4	4.6	34.8	22.9	37.3	62.3

[a] N. S Chemigroundwood pulps, average of representative tests.

Table XV. Effect of Storage on Power Requirements and Physical Properties of Chemigroundwood Pulps

Cook No.	Wood	Cooking temp., °C.	Grinder data: hp. days per ton	Grinder data: tons/sq. ft. per day	Pulp qualities: Freeness C. S., ml.	Pulp qualities: Factors: Burst, pt./lb.	Pulp qualities: Factors: Tear, g./lb.	Pulp qualities: Classification Retained by 20-mesh, %	Pulp qualities: Classification Int., %	Pulp qualities: Brightness
				No Storage						
126	Aspen	140	29.0	2.9	111	0.84	0.90	6.5	71.1	34.4
126	Birch	140	41.6	2.9	214	0.33	0.86	12.7	58.1	57.3
126	Beech	140	30.4	3.6	369	0.09	0.31	0.6	57.4	39.8
				16 hour Storage						
115	Aspen	140	32.0	2.9	210	0.76	0.95	4.1	73.4	32.2
138	Birch	150	40.0	2.3	128	0.68	1.21	31.1	56.5	48.5
115	Beech	140	28.2	4.1	271	0.15	0.51	1.3	56.1	37.1
				88 hour Storage						
138	Birch	150	35.9	4.0	186	0.81	1.23	21.8	52.0	46.9

Digester conditions for treating 48-in. wood
Treating Liquor
Chemical concentration, 1.5 lb./gal.
Chemical ratio, 6/1 $Na_2SO_3/NaHCO_3$ as Na_2CO_3
Treating Conditions
Vacuum, 26 in. for 30 min.
Treating time, 6 hr.
Total pressure, 150 p.s.i.
Grinding Conditions
Pit temperature, 130°F.
Pocket Pressure, 40 p.s.i.

strength were obtained by periods of storage up to 88 hours. Slight losses in brightness were experienced with the pulps manufactured from wood stored for 16 and 88 hours (Table XV, Fig. 23).

Table XIV. Effect of Wetting Agents on Physical Properties of Chemigroundwood Pulps

Cook No.	Wood species	Wetting agent, %	Pulp qualities: Factors: Burst, pt./lb.	Pulp qualities: Factors: Tear, g./lb.	Pulp qualities: Brightness
67	Aspen	None	1.09	0.93	39.8
123	Birch	None	0.83	0.92	52.2
132	Beech	None	0.50	0.81	39.5
139	Aspen	0.05[a]	1.17	0.90	44.4
151	Birch	0.05[a]	1.00	1.12	48.5
128	Beech	0.05[a]	0.49	0.81	38.6

[a] Triton X-100, concentration on weight of treating liquor.

The apparent advantage of this operating technique would seem to justify further investigation especially since it would be better adapted to mill practice than a process requiring immediate grinding of the wood following completion of the cook.

BLEACHING OF CHEMIGROUNDWOOD PULPS

Mechanical pulps manufactured from untreated aspen exhibit brightness characteristics equal to those ob-

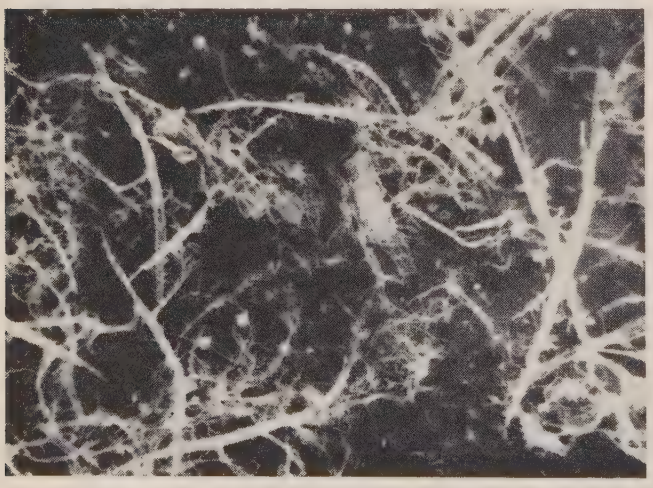


Fig. 18. Untreated aspen

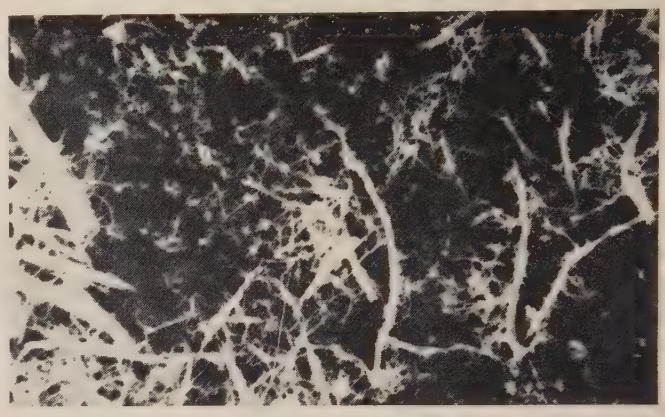


Fig. 19. Untreated birch

served for spruce and balsam pulps. However, mechanical pulps manufactured from the untreated dense hardwoods like beech, birch, and maple compare unfavorably in color with orthodox mechanical pulps produced from coniferous woods. This unfavorable color balance becomes intensified when some of these dense woods are chemically pretreated. Frequently aspen logs are also badly discolored by the treating liquors.

The low brightness of the pulps from these discolored woods appears to be caused by the presence of a high moisture or so-called "wet-wood" area in the heart of the tree which is infected with a bacterium the identity of which is still unknown. Clausen, Rees, and Kaufert (*16*) have reported that this wet-wood region containing bacterium is very difficult to penetrate because of the closure of the vessels by thickwalled growths which develop in the infected areas of the wood. These growths appear to act as bulkheads preventing the movement of the treating liquors into the wet-wood areas. During the cooking cycle as the temperature and pressure increases within the digester, the wet-wood areas appear to dehydrate with subsequent burning and discoloration of the woody tissues in these regions. In general, strong treating liquors, high-treating temperatures, and long treating times decrease final brightness values.

Photomicrographs of tangential sections of a typical aspen wood are presented in Figs. 24, 25, and 26. These photomicrographs show uninfected sapwood (Fig. 24); an infected "wet-wood" area showing characteristic bulkheads (Fig. 25); and a transition area showing the infected "wet-wood" area, a partially infected zone and an uninfected sapwood area (Fig. 26). Morphological abnormalities of the tissues exhibited by

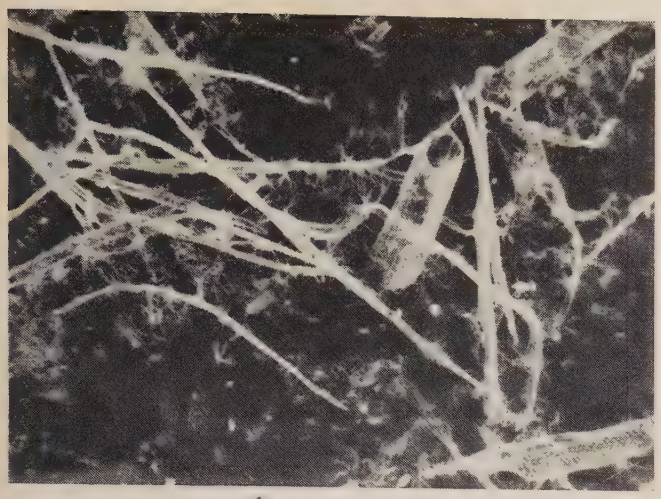


Fig. 20. Aspen chemigroundwood

these photomicrographs are the basis for the theory which has been developed to explain the inability of treating liquors to penetrate the wet-wood portion of the log and the subsequent darkening of the tissues in certain areas of infected woods. Typical data on natural and treated brightness values for several woods as well as the effect of liquor concentration and treating times on final brightness are presented in Table XVI, Fig. 27.

Notwithstanding the slightly darker color of the chemigroundwood pulps manufactured from the more mature hardwoods, it has been found that all of these pulps respond readily to bleaching with the peroxide compounds now generally employed for this purpose by the manufacturers of coniferous mechanical pulps. Both sodium peroxide and hydrogen peroxide were used in bleaching the chemigroundwood pulps manufactured during this investigation. The bleach liquors had the following general composition as applied to the weight of the unbleached pulp:

Sodium Peroxide

Sodium peroxide (Na_2O_2)	1 to 3%
Sulphuric acid (H_2SO_4)	1 to 2%
Sodium silicate (Na_2SiO_3)	5%
Magnesium sulphate ($MgSO_4 \cdot 7H_2O$)	0.05%

Hydrogen Peroxide

Hydrogen peroxide (H_2O_2)	1 to 3%
Sodium silicate (Na_2SiO_3)	4 to 8%
Sodium hydroxide (NaOH)	0 to 1.5%
Magnesium sulphate ($MgSO_4 \cdot 7H_2O$)	0.05%

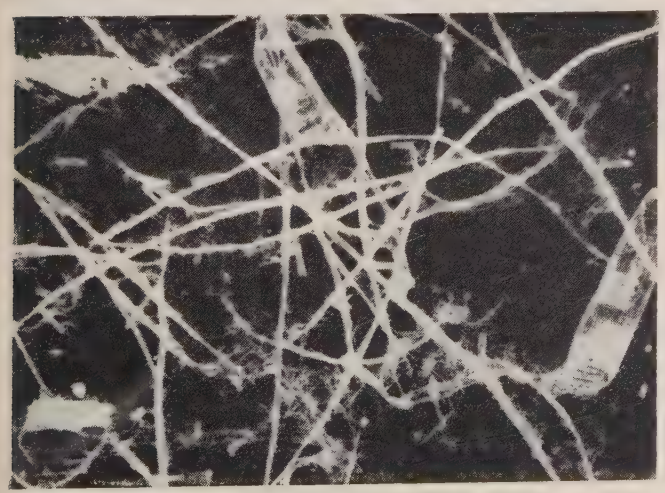


Fig. 21. Birch chemigroundwood

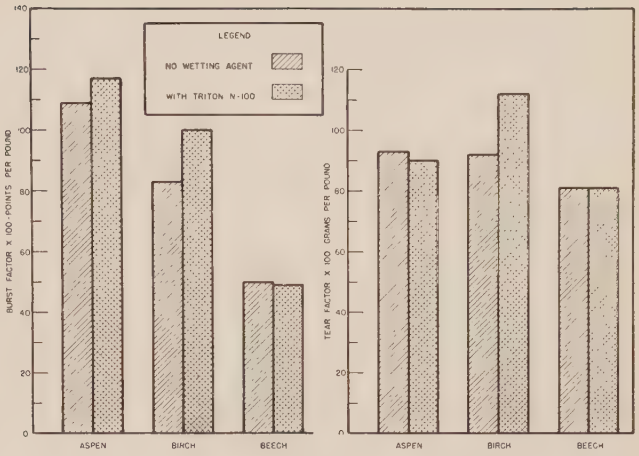


Fig. 22. Effect of wetting agents on the physical properties of chemigroundwood pulps

The analyses of the chemicals employed in these bleaching formulas were as follows:

Sodium peroxide (Na_2O_2)	96.0%
Hydrogen peroxide (H_2O_2) 100 volume	27.5%
Sodium silicate (Na_2SiO_3) Star Brand	42°Bé
Magnesium sulphate ($MgSO_4 \cdot 7H_2O$)	Technical

Bleaching of chemigroundwood pulps may be carried on using processes identical with those employed in bleaching coniferous pulps. Typical conditions employed during this investigation together with results obtained are summarized in Table XVII and presented graphically in Fig. 28.

Inspection of data included in Table XVII indicates that the brightness of the unbleached pulp has a considerable effect on the final brightness of the bleached pulps. Brightness gains of 15 points are obtainable with 2% sodium peroxide when bleaching the initially darker aspen pulps and increases of 7 points when bleaching beech pulps. The use of 3% sodium peroxide on these same pulps has made possible brightness increases up to 18 points. Birch pulps with higher initial brightness values have been bleached to a brightness level of 72 points with 2% sodium peroxide and 75 points with 3% sodium peroxide. Hydrogen peroxide may be readily substituted for sodium peroxide (Table XVII). Small additional brightness gains up to 3 points may usually be obtained by pretreating the pulps lightly with an oxidizing agent such as chlorine water or calcium hypochlorite, equivalent to 0.5% available chlorine, prior to the addition of the peroxide bleach.

Table XVI. Effect of Treatment Conditions on Brightness

Cook No.	*Wood species*	*Treating conditions — Liquor conc., lb./gal.*	*Temp., °C.*	*Time, hr.*	*Brightness Untreated*	*Treated*
...	Spruce	..	..	.	62.9	..
121	Aspen	0.75	140	6	63.0	43.8
131	Aspen (wet-wood)	1.50	150	6	63.0	30.5
125	Aspen	1.50	160	6	63.0	20.5
116	Aspen	1.00	140	6	63.0	39.0
108	Aspen	1.50	130	6	63.0	42.0
91	Aspen (wet-wood)	1.00	140	6	63.0	28.6
135	Aspen	1.50	140	8	63.0	39.6
118	Birch	1.50	140	6	51.3	57.6
137	Birch	1.50	140	7	51.3	55.9
119	Birch	1.50	140	8	51.3	46.1
130	Beech	1.50	140	7	46.0	49.4
123	Beech	1.75	140	8	46.0	45.2

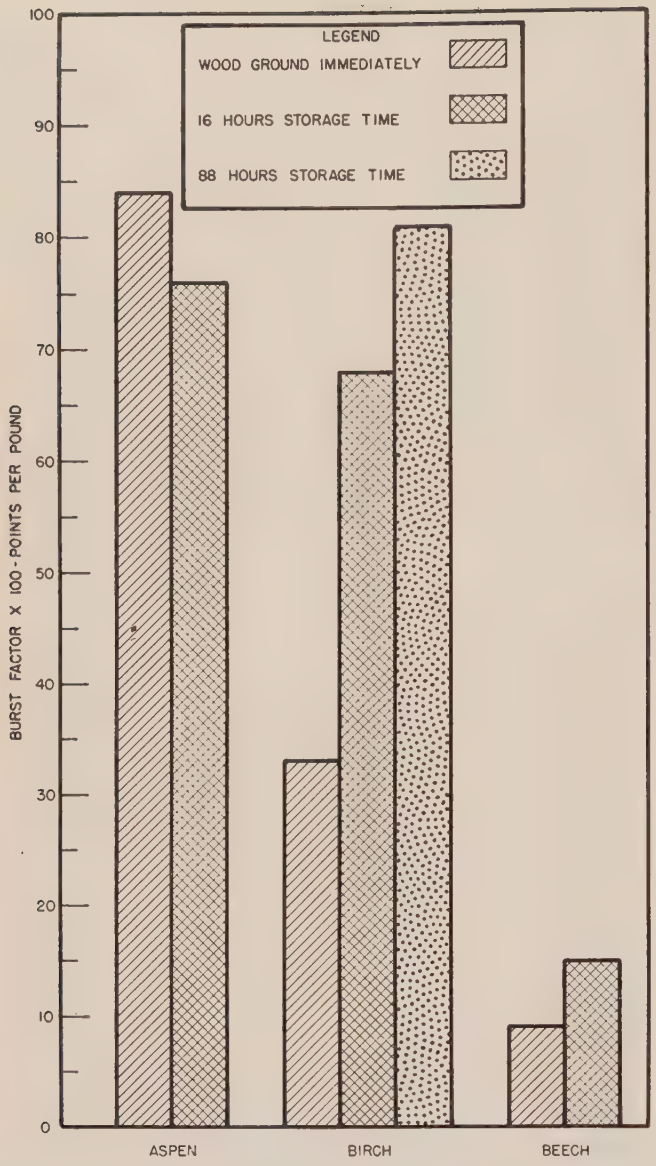


Fig. 23. Effect of storage on the bursting strength of chemigroundwood pulps

The bleaching of chemigroundwood pulps with peroxide is no more difficult than the bleaching of the coniferous mechanical pulps. Hardwood pulps of the same initial brightness bleach with approximately the same ease and to the same final brightness as the coniferous pulps. Due to the fact that the aspen and beech pulps have lower initial brightness values than the coniferous pulps, these pulps when bleached are only slightly brighter than unbleached spruce mechanical pulp. However, birch pulp bleaches readily to the same maximum brightness that may be obtained by bleaching spruce groundwood pulp.

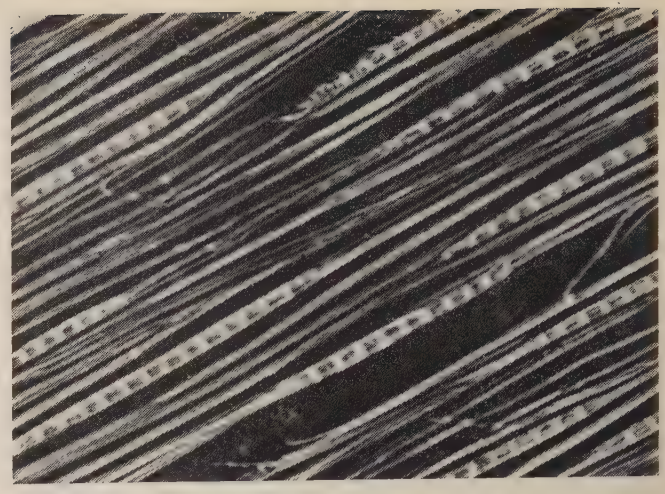


Fig. 24. Uninfected aspen sapwood

Chemigroundwood pulps have also been bleached using calcium hypochlorite, and the results obtained are very promising (*17*). When adding 10% available chlorine and from 2.5 to 10% lime ($Ca(OH)_2$) to the pulps, the brightness values have been increased from 9 to 12 units with a final brightness value of 76.9 obtainable. The addition of 10% sodium silicate to the bleach liquors containing 2 to 10% of lime results in even more remarkable brightness gains. When using 2.5% lime, brightness values of the pulp have been increased 13 units and when the amount of lime added to the pulp was increased to 10%, a brightness increment of 17 units was secured with final brightness values of 78 to 81 units (Table XVIII, Fig. 29).

Normal aspen groundwood also responded favorably to this bleaching agent. When using the same bleaching procedure brightness gains of 10 to 12 units are possible.

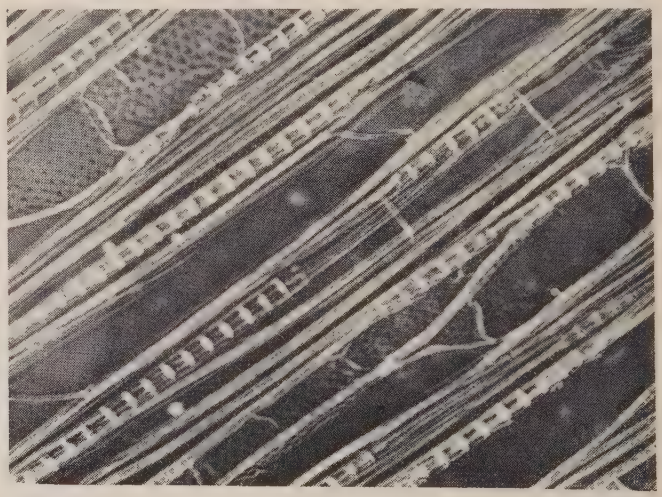


Fig. 25. Infected "wet-wood" area of aspen

Table XVII. Peroxide Bleaching of Chemigroundwood Pulps

Origin of pulp	Peroxide Type	Peroxide %	Conditions of bleach: Consistency, %	Temp., °C.	Time, hr.	Brightness: Unbleached	Brightness: Bleached	Brightness: Increase
Spruce	Na_2O_2	2	12	30	6	58.0	68.0	10.0
Aspen	Na_2O_2	2	15	30	21	45.0	60.4	15.4
Aspen	Na_2O_2	3	15	30	21	45.0	63.4	18.4
Birch	Na_2O_2	2	15	27	20	61.0	72.5	11.5
Birch	Na_2O_2	3	15	27	20	61.0	75.0	14.0
Beech	Na_2O_2	2	15	26	16	44.1	49.1	5.0
Beech	Na_2O_2	3	15	26	16	44.1	55.9	11.8
Birch	H_2O_2	2	15	45	2	52.2	61.0	8.8
Birch	H_2O_2	3	15	45	2	52.2	63.6	11.4

Table XVIII. Calcium Hypochlorite Bleaching of Aspen Chemigroundwood Pulps

Conditions of bleach						Brightness		
Available chlorine, %	Initial pH	$Ca(OH)_2$, %	Sodium Silicate, %	Consistency, %	Temperature, °F.	Unbleached	Bleached	Increase
10	11.39	2.5	..	3	86	64.3	74.1	9.8
10	11.52	5.0	..	3	86	64.3	76.9	12.6
10	11.68	7.5	..	3	86	64.3	73.3	9.0
10	11.7	10.0	..	3	86	64.3	73.3	9.0
10	10.28	2.5	10	3	86	64.3	78.0	13.7
10	10.6	5.0	10	3	86	64.3	79.0	14.7
10	10.95	7.0	10	3	86	64.3	80.4	16.1
10	11.02	10.0	10	3	86	64.3	81.2	16.9

Fig. 26. Transition area: **A. uninfected sapwood, B. partially infected "wet-wood" area, and C. infected "wet-wood" area**

Additional research on pretreatment methods for all of these hardwoods should result in pulps of higher initial brightness and, therefore, in eventual higher final brightness.

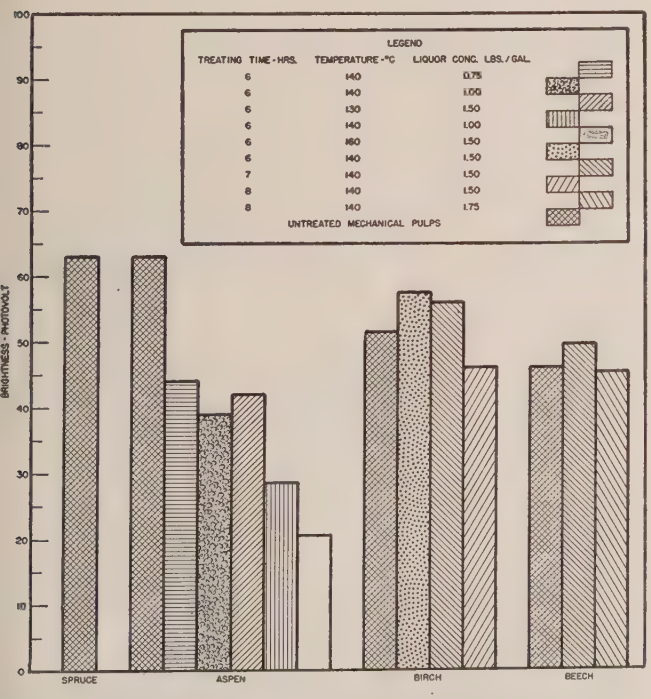


Fig. 27. Effect of wood condition, treating time, temperature, and liquor concentration on brightness

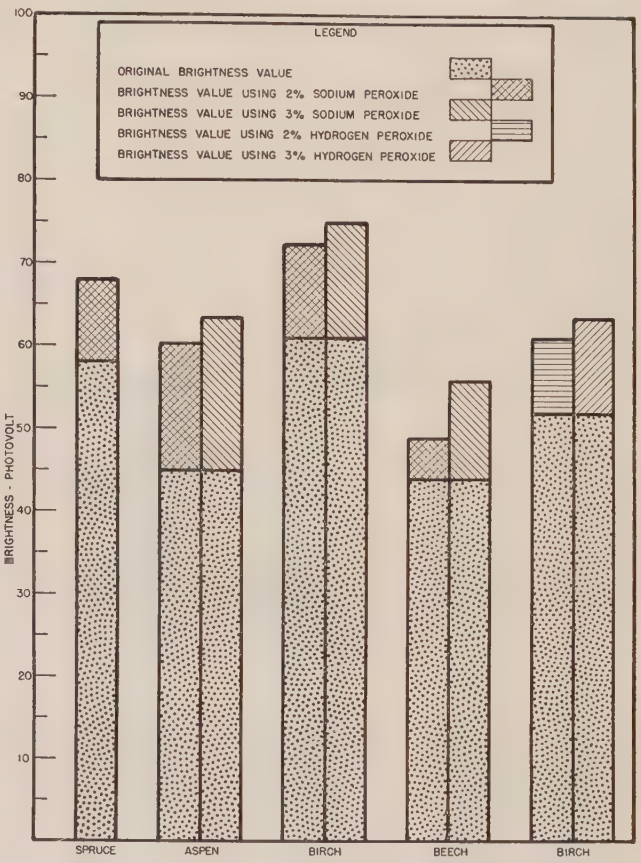


Fig. 28. Peroxide bleaching of chemigroundwood pulps

ECONOMIC ADVANTAGES OF THE CHEMIGROUNDWOOD PROCESS

In addition to the greatly superior quality of chemigroundwood pulp and the very obvious advantage of utilizing wood species which are cheaper and more readily available than the conifers, this process has several additional factors distinctly in its favor. Three of these economic advantages are shown in Fig. 30. Selecting from this figure the data for spruce, aspen, and birch as a basis for comparing the economics of groundwood pulp manufacture from these woods, the following facts are demonstrated:

1. Aspen and birch pulp may be manufactured with an expenditure of approximately 60% of the power required for the manufacture of spruce pulp. On a cost basis this represents an economy in electrical energy of more than $2.00 per ton of pulp manufactured. Beech and maple woods are pulped with even greater ease.

2. The production rate for aspen pulp is approximately 20% and for birch pulp it is over 30% greater than it is for spruce pulp. This factor would enable existing equipment to increase its production by an equivalent amount when grinding these hardwoods and

reduce the investment in new plants by a like percentage. Beech and maple woods are pulped at a considerably higher rate than are aspen or birch.

3. The greatest economic advantage of the chemigroundwood pulps is the fact that the density of the most available hardwoods enables them to produce approximately 25% more pulp per cord of wood than can be obtained from the coniferous woods like spruce. Birch wood, for example, yields approximately 2900 pounds of chemigroundwood pulp per cord in comparison with not more than 2200 pounds of mechanical pulp from spruce. This 700 pounds of additional pulp produced by the dense hardwoods has a value of

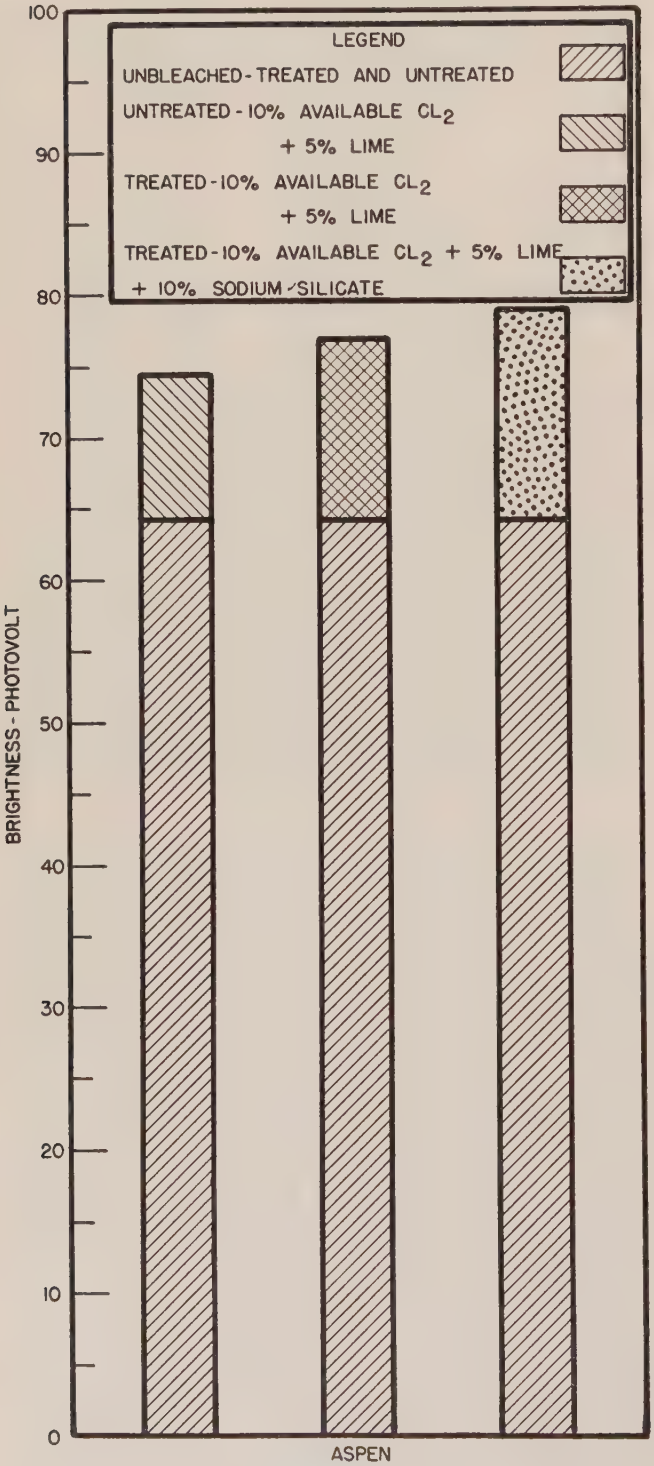


Fig. 29. Hypochlorite bleaching of aspen chemigroundwood pulps

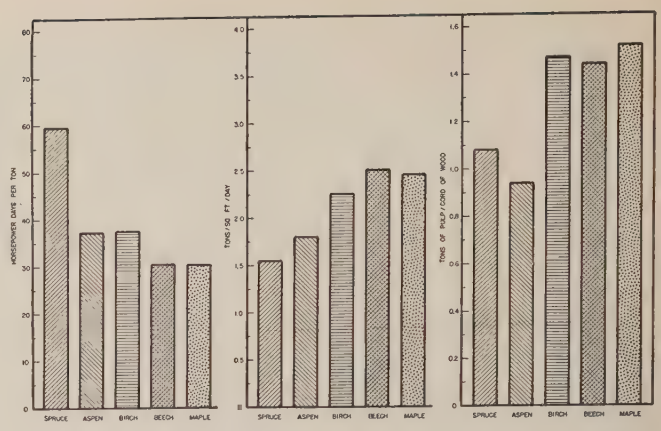


Fig. 30. Economic advantages of the chemigroundwood process

$22.75 at current prices of $65.00 per ton for spruce mechanical pulp. This single advantage is sufficiently great to more than several times absorb the additional costs of steam, chemicals, and labor which are required for the manufacture of chemigroundwood pulps.

The process developed and described in this paper has been covered by patent claims designed to protect the interests of the sponsors of the research program. If patents are granted, it is the intention of the sponsors to make processes so covered generally available to the industry at nominal fees. Other pulp producers can, if they desire, participate in the research program of the Empire State Paper Research Associates, Inc. and thereby assist in the development of satisfactory pulping methods for other species of American woods now considered unsuited for pulp manufacture.

LITERATURE CITED

1. Harper, V. L., Timber Resources of New England and New York with Reference to Pulpwood Supplies. U.S.D.A., Northeastern Forest Experiment Station, Station Paper No. 5. (1947).
2. Rue, J. D., *Paper Trade J.* 81, 16: 57–59 (Oct. 15, 1925); *Tech. Assoc. Papers* 9: 140–142 (June, 1926); *C. A.* 20: 285.
3. Schacht, W., *Paper* 17, 21: 17–18 (Feb. 2, 1916); *C. A.* 10: 1268.
4. Anon., *Paper* 18, 26: 13–16 (Sept. 6, 1916); *Chem. Eng.* 24, 3: 133–137 (1916).
5. Anon., *Paper* 17, 26: 11–12 (Mar. 8, 1916) *C. A.* 10: 1268.
6. Anon., *Paper* 17, 18: 11–15 (Jan. 12, 1916); *C. A.* 10: 1267.
7. Anon., *Paper* 18, 6: 19 (April 19, 1916).
8. Anon., *Paper* 17, 21: 18 (Feb. 2, 1916).
9. Schwalbe, C. G., *Paper Mill* 28, 44: 32–34 (Oct. 30, 1915).
10. Klein, A., *Wochbl. Papierfabr.* 52, 32: 2593–2594 (Aug. 13, 1921); *Paper Trade J.* 74, 1: 49 (Jan. 7, 1922).
11. Munro, W. A., *Paper* 28, 8: 26–27 (April 27, 1921); *Paper Trade J.* 72, 16: 217, 219 (April 14, 1921); *C. A.* 15: 2183.
12. Bendryshev, A. P. and Shapiro, A. D., *Wochbl. Papierfabr.* 71, 3: 24–25 (Jan. 20, 1940); (through *B. I. P. C.* 10: 331 and *C. A.* 33: 7100).
13. Lougheed, E. H., *Pulp Paper Mag. Canada* 46, 3: 165–175 (Feb. 1945); *B. I. P. C.* 15: 275; *C. A.* 39: 2199.
14. Hyttinen, A. and Schafer, E. R. *Tappi* 32, 2: 79–85 (Feb. 1949).
15. Wirpsa, V. J. and Libby, C. E., Penetration of Neutral Sulphite Cooking Liquors into Birch Wood, Unpublished M. S. Thesis, New York State College of Forestry, Jan., 1948.
16. Clausen, V. H., Rees, L. W., Kaufort, F. H., Unpublished Paper. University of Minnesota (1949).
17. Born, David and O'Neil, F. W., The Application of Chlorine Compounds in the Bleaching of Poplar Groundwood, Unpublished M. S. Thesis, New York State College of Forestry.

Received, Feb. 23, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 20–23, 1950.

The data reported in this paper were developed as the result of a cooperative research project sponsored by the Empire State Paper Research Associates, Inc. and The New York State College of Forestry. Much credit for the success of this investigation belongs to the officers of ESPRA organization the administrators of The New York State College of Forestry, and the personnel of the research staff who faithfully carried out the work in the laboratory.

Permanence of Wet Strength Paper

C. S. MAXWELL and W. F. REYNOLDS

The permanence of wet-strength paper is discussed from two angles (1) permanence of the wet-strength properties and (2) permanence of the paper itself. The factors mentioned that affect the permanence of the wet-strength properties are: nature of the wet-strength agent, pH of the paper during storage, temperature and humidity during storage, degree of cure of the wet-strength agent, and action of microorganisms. In regard to the permanence of wet-strength paper itself, it is pointed out that many of the tests established for predicting the permanence of normal paper are unreliable when applied to the usual wet-strength papers. Tests that are affected are disperse viscosity, copper number, extracted pH, and folding endurance before and after oven aging.

Ten years ago wet-strength paper was a rarity. Since then it has been produced in steadily increasing quantity until today it is conservatively estimated that over 400 million pounds of paper were treated for improved wet strength in this past year.

In some of its applications wet-strength paper is required to have only a short useful life but in others it must maintain its useful properties for long periods of time. For these latter applications the question of the permanence of such wet-strength papers is of great importance. This question is pertinent from two entirely separate angles: (1) the permanence of the wet-strength properties, and (2) the permanence of the paper itself. These two qualities are really quite different so they will be kept separate in the discussion that follows.

PERMANENCE OF WET STRENGTH PROPERTIES

There are a number of known, and probably an equal number of unknown factors that influence the permanence of wet-strength properties. Researchers are continually trying to bring to light the unknown factors and trying to understand better the factors of which they are already aware. A list of these known factors looks something like this: (1) nature of wet-strength agent, (2) pH of sheet during storage, (3) storage temperature, (4) relative humidity during storage, (5) degree of cure of the wet-strength agent, and (6) action of microorganisms.

In practice it is very seldom that the effect of any one of these variables can be separated from those of other variables, but under controlled laboratory conditions some degree of separation is possible. Therefore, each of the above enumerated factors is considered in turn.

Nature of Wet-Strength Agent

The specific nature of the agent or process has a great deal to do with the permanence of the wet-strength properties imparted. Some materials impart only a very temporary wet strength while other materials or processes impart wet strength that is permanent under wide pH conditions. Most commercial papers are made and used in the range of pH 4 to pH 7 so it is quite logical that the permanence of the wet strength imparted by the various methods be compared in this range. To insure constant pH conditions during such a comparison, the use of a buffer solution as suggested by Britt (*1*) has proved useful. Under such conditions the order of permanence of a group of wet-strength agents (or processes) would be approximately as follows: (1) parchment process, (2) viscose, (3) melamine formaldehyde, (4) urea formaldehyde, (5) glue formaldehyde, and (6) locust bean gum, guar.

At the present time, practical considerations have largely restricted the wet strength field to melamine and urea resins applied to the slush stock although the other materials or methods listed are being used where special effects are needed or where higher costs are warranted. As most of our studies have been limited to melamine resins, most of our comments will be confined to this specific agent.

Comparisons of the stability of the wet-strength properties of papers treated with melamine and urea resins and a combination of the two are shown in Fig. 1, for which the conditions of hydrolysis (87°C. at pH 6) were chosen arbitrarily. Higher temperature or lower pH would have speeded up the rate of hydrolysis while lower temperature or higher pH would have retarded it. From this series of curves it is evident that, at least under the test conditions chosen, the melamine-resin treated paper has a more permanent strength than does the urea-resin treated sheet, while the sheet treated with both resins is, as would be expected, between the two. The actual products used in this study were a melamine-formaldehyde resin acid colloid, and a urea-formaldehyde (UF) bisulphite resin, both applied to unbleached kraft stock. A heavy cure was given to enable the slower curing urea-resin treated sheets to develop approximately the same wet tensile strength as the melamine resin treated. As far as rate of hydrolysis goes, other types of UF resins behave similarly to the one tested.

Of course, most uses of wet-strength paper do not require submersion in a buffer solution, but rather exposure to occasional wetting and/or variable temperatures, humidities, and possibly pH conditions. To study these factors, the resin-treated sheets were made and stored under carefully controlled conditions, each factor being considered separately as follows:

Effect of pH

It is well established that urea and melamine resins tend to hydrolyze more readily under acid conditions than under neutral or alkaline conditions. It would therefore be expected that wet-strength papers made with such resins under acidic conditions would lose the effect of the resin bonding more rapidly than similar papers made at a higher pH level, assuming that suffi-

C. S. Maxwell and W. F. Reynolds, Members TAPPI; Stamford Research Laboratories, American Cyanamid Co., Stamford, Conn.

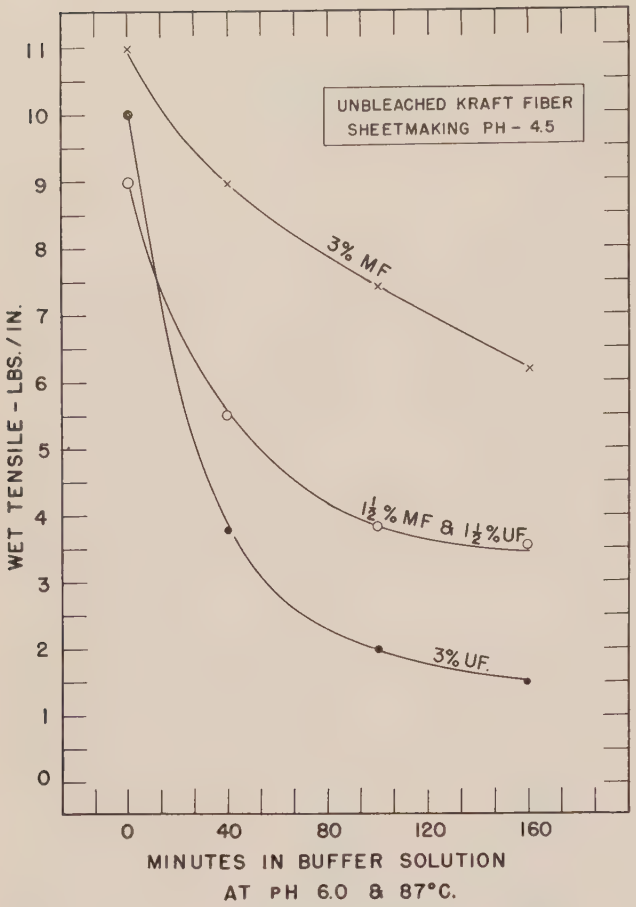


Fig. 1. Loss of wet strength on hydrolysis, melamine vs. urea resin treated papers

cient buffer is present in both instances to maintain the original pH conditions. Such a comparison of melamine-resin acid colloid-treated papers prepared at pH 4.5 and 5.6, both aged at 100°F. and 90% R.H., is shown in Fig. 2.

Storage Temperature

The effect of temperature on wet-strength permanence is fairly easy to determine. Figure 3 shows two curves on a single melamine resin treated paper that has been aged under different temperatures at a constant humidity.

Relative Humidity during Storage

At any given temperature, the loss of wet strength is accelerated by increases in humidity although this is of importance only at higher temperatures. This is demonstrated by the following curves (Fig. 4) which show the change of wet strength at high and low humidity at a temperature of 85°F. At low relative humidity there is actually a slight increase in wet strength which indicates that the resin is undergoing additional cure, and this effect is greater than any hydrolytic effect.

Degree of Cure of the Wet-Strength Resin

The curve of the wet-strength loss on aging can be considered as a continuation of the curve of wet-strength development on curing. When an uncured resin treated sheet is allowed to age under fixed conditions the wet strength develops rapidly at first, then at a slower rate until maximum wet strength is obtained, and finally, on continued aging, the wet strength falls off. However, a highly heat-cured sheet shows no such development of wet strength on aging but actually shows a rapid initial drop in wet strength.

The curves in Fig. 5 show the relative wet strengths of a melamine-resin treated paper under three conditions of cure. The striking fact here is that the air-dried paper develops excellent wet strength so that after several weeks storage it is practically as good in this respect as the heat-cured sheets. These curves are also evidence that a heavy cure, while it develops an immediate high wet strength, does not improve the permanence of the treatment.

Action of Microorganisms

The wet-strength resins that contain formaldehyde tend to maintain a low concentration of free formaldehyde in papers so treated and therefore probably impart bactericidal and fungicidal properties to paper to a small degree. However, some uses of wet-strength paper involve contact with wet earth or other locations where the microorganism content is high, so additional treatment may be required for adequate protection in such cases.

We have found that in long term testing and in exhibits, the factor of microorganism activity must be considered. We have had weights hanging on wet-strength paper strips in water containing mercury salts for several years, while the same papers lasted only a few weeks with no preservative present. The preservative protects the cellulose of the sheet itself and probably has no effect on the resin bonding.

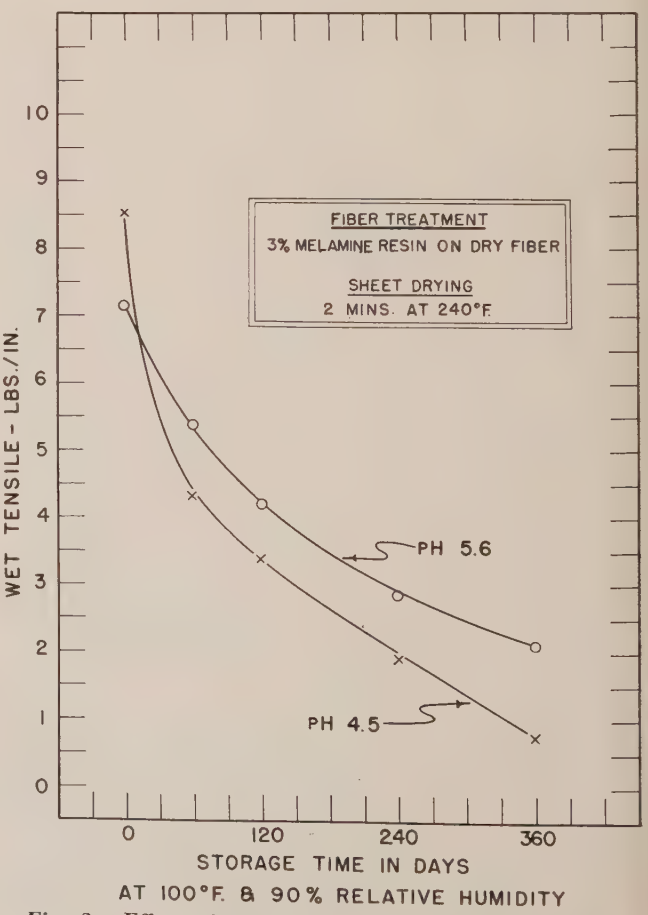


Fig. 2. Effect of pH on permanence of wet strength

Methods of Improving Permanence of Wet-Strength Properties

Based on the above information there are certain steps that can be taken to improve the permanence of wet-strength properties in paper:

1. Protect the paper from microorganisms if the use requirements of the paper require it.
2. Use wet-strength agents that resist hydrolysis under the use requirements. In this connection it can be mentioned that while melamine resins are definitely more resistant to hydrolysis than urea resins, there are certain acidic conditions under which even the melamine resin does not have sufficient resistance. There are several wet-strength materials potentially available that are very resistant to such acid hydrolysis.
3. Maintain high pH conditions during paper manufacture as this results in papers having more stable wet strength. This same high pH, however, tends to retard the cure of the resin in the paper.
4. Store wet-strength paper under cool or dry conditions.

PERMANENCE OF THE PAPER ITSELF

The manufacturers and users of ledger and record papers have always been interested in permanence and had established certain criteria for predicting the relative permanence of paper—such as purity of fibers (disperse viscosity (*4*), copper number (*5*)), extracted pH of the paper (*8*), and folding endurance of the paper before and after oven aging (*6*).

As the use of wet-strength resins spread, they found their way into the "permanent" papers which immediately brought up the question as to what possible effects they could have on the permanence of the paper itself or on the validity of the test methods.

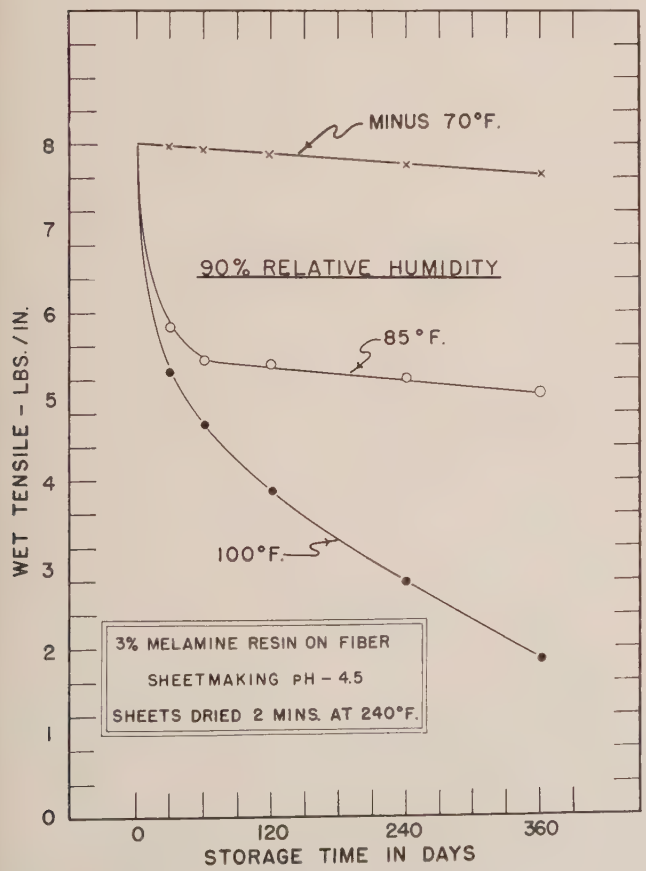


Fig. 3. Effect of temperature on permanence of wet strength

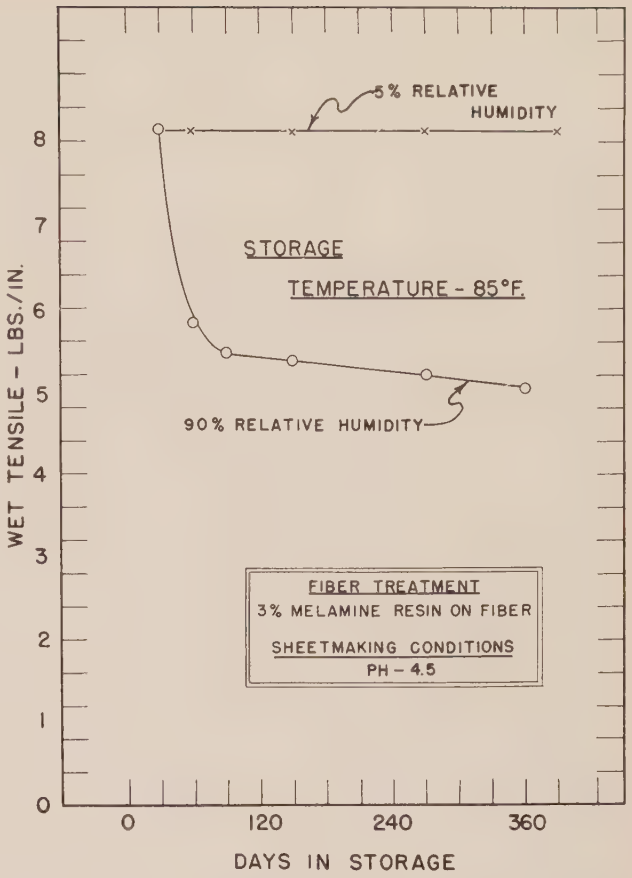


Fig. 4. Effect of humidity on permanence of wet strength

One brief mention of the effect of melamine resin on paper permanence, as measured by loss of folding endurance, was made in an earlier publication (*7*). Since this first work was done, the study has been expanded and attempts have been made to correlate the folding endurance tests with the disperse viscosity of cellulose in cupriethylenediamine. The sheets for this study were prepared on a Nash handsheet machine at a basis weight of 22 pounds per ream (17 × 22—500). The test data are shown in Table I.

It is clear that the two tests—folding endurance and viscosity in cupriethylenediamine—do not agree at all for the resin treated paper. The excellent folding endurance of the resin-treated sheet is further improved by oven aging, while the viscosity is lowered. On the other hand, the nonresin treated sheet behaves as expected and shows both a loss of folding endurance and loss in viscosity after oven aging. The explanation presumably is that the resin continues to cure during the aging period thereby continuing to improve the folding endurance, and this tendency is sufficiently great to more than overcome any loss of fold caused by cellulose degradation.

The lower viscosity values obtained with the resin-treated paper may indicate more severe cellulose degradation—as would be expected in the specific case illustrated because of the lower pH conditions—but the presence of undispersible debris (presumably resin) in the cupriethylenediamine solution may be influencing the results.

Table I. Effect of Accelerated Aging on Rag Paper

Melamine resin treatment	Hours aged in oven at 100°C.	Melamine, % resin in sheet, % (by analysis)	Tensile strength, lb./in. Dry	Tensile strength, lb./in. Wet	Fold MIT	Viscosity, cp.	pH of sheet[a] (hot extraction)
None	0	0	26.0	1.8	2083	66.6	7.0
	72	0	26.2	3.6	1763	31.5	6.8
3%	0	2.36	35.2	15.4	4100	41.6[b]	5.9
	72	2.41	38.6	22.2	5597	24.5[b]	5.9

[a] No pH adjustment of stock made.
[b] Some undispersed sediment, presumably due to the resin, may have influenced these values.

When the melamine acid colloid resin was first introduced as a wet-strength resin, there was some concern expressed over the introduction of the acid material into the paper system. In actual practice, the small amount of acid added with the resin is usually insufficient to reduce the system to the desired pH so that other acidic materials (e.g., alum) are usually added also. In the case illustrated in Table I in which soft tap water was used for sheet making, it is evident that the addition of 3% resin reduced the extracted pH (hot) from about 7 to 6. In systems using more highly-buffered water, the change in pH is much less and in many cases is not easily measured.

To further complicate the situation, it appears that the presence of melamine resin itself affects the extracted (hot) pH. According to a private communication (*9*) from the Paper Section of the National Bureau of Standards, unpublished data show that: "Whereas the pH by hot extraction of nonwet-strength papers is usually lower by about 0.6 unit than the pH by cold extraction, the presence of melamine brings the values obtained by the two methods closer together. The hot-extraction value is sometimes higher than the cold-extraction value, especially if the melamine content is high. That this is due to changes in the melamine resin was confirmed by heating some melamine resin in water on the steam bath for about an hour, with and without fibers present. The pH became higher in each case upon heating."

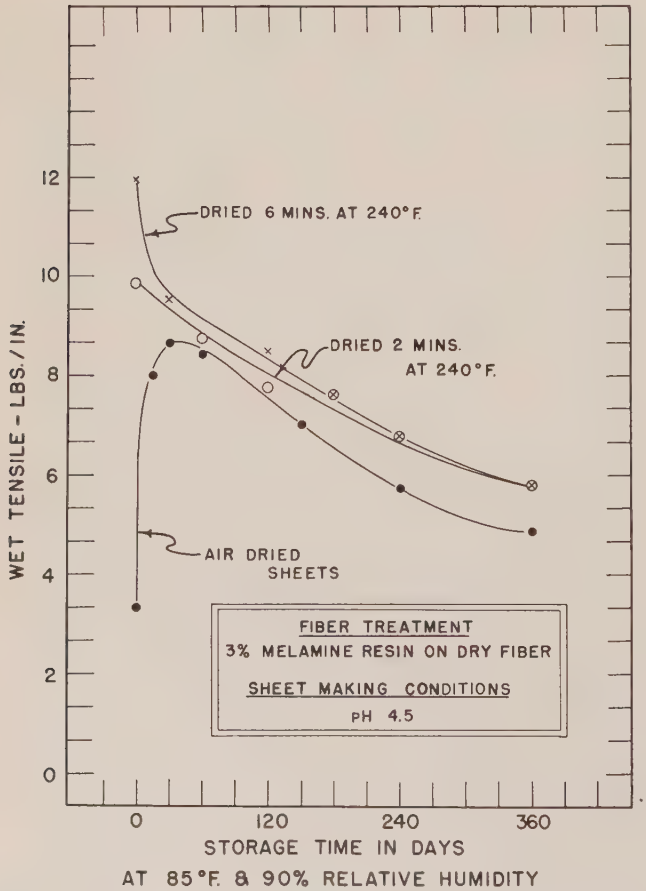


Fig. 5. Effect of degree of cure on permanence of wet strength

It is thought that the melamine resin tends to hydrolyze under the conditions of the hot extraction and the free melamine formed gives a higher pH due to its basic nature. On the other hand, under similar conditions, alum also tends to hydrolyze but the products of hydrolysis are acidic so tend to give a lower pH reading (*10*). The presence of both melamine resin and alum in a paper can really complicate the interpretation of this test.

Another method that has been used to predict the permanence of paper is the copper number (*5*). Incorporated in a recent revision of this method is the notation that the method is not valid if melamine resin is present. Of course, the method depends on a measurement of the aldehyde groups present and melamine resin—or other resins containing formaldehyde—are certain to invalidate the results.

The data reviewed here certainly are too sketchy to warrant the conclusion that the melamine resin treatment has any effect one way or the other on the permanence of paper but it is clearly evident that many of the established tests for permanence are not valid when performed on such wet-strength papers. In fact, it would be quite possible to "up grade" a paper to pass the folding endurance test on aging with a small amount of the resin.

LITERATURE CITED

1. Britt, K. W., *Paper Ind.*, p. 37–46 (April), 1944).
2. Kantrowitz, M. S., Spencer, E. W., and Simmons, R. H., U. S. Government Printing Office, Technical Bulletin No. 22 (1940).
3. Scribner, B. W., *Paper Mill* 53, No. 24: 4–5; No. 25: 13–15 (June 14, 21, 1930).
4. TAPPI Standard T-230 sm-46 (Cupriethylenediamine Disperse Viscosity).
5. TAPPI Standard T-430 m-47 (Copper number).
6. TAPPI Standard T-453 m-48 (Heat Test for Relative Stability of Paper).
7. Landes, C. G., and Maxwell, C. S., *Paper Trade J.*, 121, No. 6: 37–46 (Aug. 9, 1945); *Tech. Assoc. Papers* 28: 205–214 (1945).
8. TAPPI Standard T-435 m-42 (pH of Paper Extracts).
9. Private communication from the Paper Section of the National Bureau of Standards dated Nov. 9, 1949.
10. Launer, H. F., Research Paper RP 1205, *J. Research Nat. Bureau Standards* V. 22 (May, 1939).

Received Feb. 10, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 20–23, 1950.

The authors wish to acknowledge the contributions and assistance of C. G. Landes, J. Studeny, A. F. Blockman, C. A. Davis, and R. Weaver. Permission of the American Cyanamid Co. to publish this material is greatly appreciated.

Wax from Douglas-Fir Bark

E. F. KURTH and H. J. KIEFER

A major constituent of the extractives from Douglas-fir bark is a hard, nontacky wax. Other commercially important extractives present in this bark are tannin and dihydroquercetin. The present paper gives data on the optimum conditions for the extraction of the bark and the chemical composition, properties, and yields of the wax. The wax soluble in benzene and chlorinated aliphatic hydrocarbon type solvents amounts to 5 to 10% of the weight of the dry bark. It is readily separated into two fractions with aliphatic hydrocarbon type solvents. The fraction soluble in hot hexane is a light-colored wax consisting of approximately 20% lignoceryl alcohol, 60% lignoceryl acid, and 20% ferulic acid (4-hydroxy-3 methoxy cinnamic acid). The fraction insoluble in hexane is a light-brown to reddish-brown material, which on saponification gave a fatty acid mixture in about 25% yield, a dark-colored phlobaphene in 24% yield, an ethyl ether soluble acid fraction in 26% yield, unsaponifiable matter in 5% yield, and glycerol.

Based on an annual cut of 6 billion board feet of Douglas-fir (*Pseudotsuga taxifolia* (Poir.) Britt.) lumber in the states of Oregon and Washington, the potential annual yield of bark from these sawlogs alone approximates 125 million cubic feet. Much additional bark could be made available by the pulp and paper, plywood, and pole and piling industries. Most of this bark is now used as fuel or is burned as a means of disposal. Because of the vast supply of Douglas-fir bark available as a raw material, the Oregon Forest Products Laboratory began investigations in 1947 on its chemical composition and possible utilization. Previous to this time there was little information available concerning the chemistry of this material.

Douglas-fir bark varies widely in thickness, density, and chemical composition depending on the age of the trees and position of the bark on the tree. It can be mechanically separated into cork, short needlelike bast fibers, and an amorphous powder by first chipping, hogging, or shredding the moist bark, then screening and regrinding the resilient cork particles in attrition or ball mills. The cork is interspersed in the reddish-brown bark as light-colored layers varying in thickness from $^1/_{32}$ to $^3/_4$ inches (Fig. 1). The bark from sawlogs has been found in this laboratory to contain by weight from 25 to over 50% cork, 30 to 42% of short needlelike bast fibers, and 20 to 35% of an amorphous powder passing a U. S. No. 100 sieve. All of these bark products contain tannin, waxes, dihydroquercetin, and other extractives.

Cork particles from several lots of bark have been found to contain from 5.0 to 9.4% of a light-colored wax soluble in hexane or paraffin hydrocarbon solvents, plus 2.5 to 3.5% of a light-brown wax soluble in benzene or chlorinated paraffin hydrocarbon solvents. The total wax content, calculated on the oven-dry weight of cork, was 7.5 to 12.9%. Further extraction of the wax-free cork particles with ethyl ether has given relatively pure dihydroquercetin in yields up to 20% of the oven-dry weight of unextracted cork. This extractive was obtained in the form of a white powder, melting point 234 to 236°C. without purification. Solubility of the cork particles in an alcohol-benzene mixture was 35 to 40%.

The bast fiber-fraction passing a U. S. No. 40 sieve and retained on a No. 80 sieve is essentially a lignocellulose material. It also contains wax, dihydroquercetin, tannin, and other extractives. On the extractive-free basis, the bast fibers have been found to contain about 55% of white cellulosic material when isolated with sodium chlorite in acetic acid solution (*6*) and 45% of "lignin" material as determined by the 72% sulphuric acid procedure. The "lignin" from the bast fibers is different from wood lignin in that it contains a carboxyl group and is low in methoxyl groups.

THE CHEMICAL NATURE OF THE EXTRACTIVES

The over-all extractive content of Douglas-fir bark is high. It was found to range from 28 to 43% depending on the age of the tree. Preliminary work on the chemical nature of the extractives indicated that relatively clear-cut fractions were obtained when Douglas-fir bark was extracted with hexane, benzene or trichloroethylene, ethyl ether, ethanol, and hot water in the order given. For example, the yield and nature of the extractives from a bark sample from the bottom of 80- to 95-year old trees are shown in Table I. Acetone was found to be not as good a solvent for the tannin and phlobaphene as ethanol. Benzene and chlorinated paraffin hydrocarbon solvents extracted the hexane soluble wax as well as a brown wax that is insoluble in hexane. This dark-colored material is less desirable commercially from the standpoint of color, but it has useful properties.

Table I. Extractives in Bark from 80- to 95-Year Old Trees

(Per cent of oven-dry weight of bark)

Extractive	*Yield, %*	*Solvent*
Light-colored wax	5.47	Hexane
Light-brown wax	2.52	Benzene
Dihydroquercetin	5.95	Ethyl ether
Tannin and phlobaphene	7.70	Acetone
Tannin and nontannins (carbohydrates)	6.68	Hot water
Sum of five extractives	28.32	

WAX EXTRACTION

In the course of the experimental work, bark was extracted with hexane and also with benzene in the stainless steel extractor shown in Fig. 2. Stainless steel was selected because iron and copper caused discoloration of the wax, particularly in the presence of water. In this

E. F. Kurth, Chief, Chemical Utilization Section, Oregon Forest Products Laboratory, and Professor of Wood Chemistry, Oregon State College, Corvallis, Ore.; H. J. Kiefer, Research Assistant, Oregon Forest Products Laboratory, Corvallis, Ore.

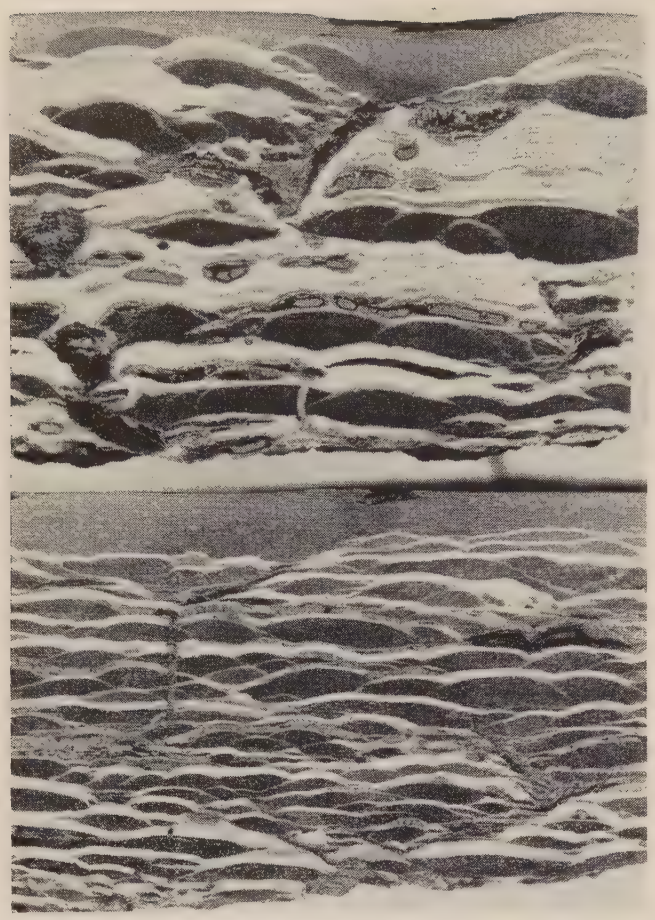


Fig. 1. Douglas-fir bark with narrow and wide cork layers

extractor, ground bark was charged in a vertical vessel 12 inches in diameter and 5 feet high. Hot solvent was pumped upward through the bark and into the evaporator where the solvent was removed from the extracted wax by steam distillation. The water-immiscible solvent was recovered from the condensate in a solvent-water separator and returned to storage by gravity flow. At the end of the extraction, the solvent retained on the bark was recovered by steaming.

A series of extractions were made to determine the effect upon the extraction efficiency of such factors as particle size and moisture content of the bark, time of extraction, solvent flow-rate, ratio of solvent to bark, and temperature of the solvent.

Preparation of the Bark for Extraction

The early trial runs clearly demonstrated that proper grinding of the bark was an important factor for successful extraction with hot solvents. When dry bark was ground in a hammer mill, the product contained a large proportion of fines, which prevented satisfactory extraction. The dry-ground bark swelled and packed in the extraction vessel and restricted passage of the solvent through the bark and hampered steaming off of "hold up" solvent. In addition, the fines plugged the screens and contaminated the wax. It was found that wet bark, as obtained in commercial logging operations, first ground in a hog and then in a Rietz Disintegrator equipped with a screen containing $^3/_8$-inch perforations was satisfactory. Table II shows a screen analysis of the ground bark.

Table II. Screen Analysis of Ground Bark

Retained on U. S. sieve No.	*Per cent*
20	56.7
40	15.6
60	10.9
100	7.6
150	3.3
200	2.0
Through 200	2.8

The density of the ground bark was approximately 13 pounds per cubic foot, calculated on the oven-dry basis. The weights of the ground bark per cubic foot in the range of moisture content between 1.67 and 36.55% are given in Table III. When the extraction vessel was filled to within 10 inches of the top, it contained 35 to 40 pounds of dry bark.

Table III. Density of Ground Bark

Moisture content, %	*Moist weight, lb./cu. ft.*	*Oven-dry weight, lb./cu. ft.*
1.67	13.16	12.94
8.76	13.85	12.64
25.30	17.65	13.18
36.55	19.40	12.30

Effect of Moisture Content

A variation in moisture content of the bark charge within the range of 1.7 to 44.9% had little effect on the efficiency of extraction. With hot benzene or hot hexane as the solvents in this type of extractor, it was not necessary to dry the bark before extraction. The normal solvent feed pump gage pressure was 4 to 7 pounds, whereas bark with a moisture content of 1.7% gave the highest pump pressure (14 pounds). Bark with a moisture content above 40% was found to require a slightly higher solvent-to-bark ratio to give comparable wax extraction than bark with a lower moisture content.

Table IV shows the data obtained on runs made at a flow rate of 35 gallons per hour with bark at different moisture content values. The data in the "wax extracted" column were based on the actual yield of moisture-free, sediment-free wax as compared with the amount of wax obtained from dry bark by extraction for 6 hours in a Soxhlet extractor in the laboratory. Approximately the same results were obtained with bark as were previously found with the extraction of wax from the lignin residue produced in the saccharification of Douglas-fir sawmill residues (*5*).

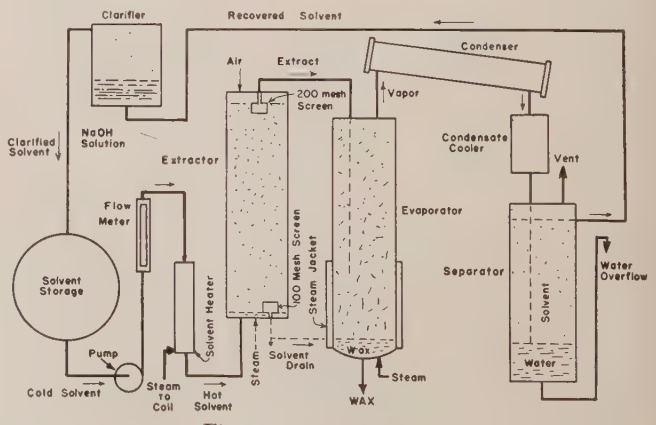


Fig. 2. Wax extractor

Table IV. Effect of Moisture Content on Benzene Extraction

Run No.	Moisture content, %	Solvent to bark ratio, gal./lb.	Wax extracted, %
17	1.67	2.80	80.8
19	8.76	2.87	91.4
12	9.80	2.84	88.0
20	33.30	3.22	93.6
21	32.90	3.02	91.8
18	40.20	2.74	70.0
11	44.90	3.45	89.2

Solvent to Bark Ratio

This ratio is primarily a function of the product of flow rate times period of extraction and is affected by the bark capacity of the extraction vessel. It appeared that a flow rate within the range of 5 to 7 linear feet per hour and a benzene-to-bark ratio of 3 to 3.5 gallons per pound of dry bark was satisfactory. These ratios were also found the most satisfactory in the extraction of wax from Douglas-fir lignin residue (*5*). Multiple extraction vessels in series would undoubtedly decrease the solvent-to-bark ratio.

Temperature of Solvent

Under the time and solvent-flow rate conditions of extraction, the yield of wax decreased with reduction in the extraction temperature. With wet bark, the efficiency of extraction with benzene was considerably decreased below 160°F.

Solvent Recovery

It was found that after each extraction, a 2-hour period was required to steam off the solvent retained by the bark residue. In a series of 14 consecutive runs, the total solvent loss for the series was 4.5 gallons. During the 14 runs, a total of 1470 gallons of benzene was pumped through the extraction unit; therefore, the solvent recovery for the series was 99.7%.

Optimum Extraction

In a nonpressure extraction vessel, the optimum conditions for extraction with benzene appeared to be as follows:

Moisture content of bark	10 to 40%
Extraction time	3 hours
Flow rate of solvent	35 gallons per hour
Temperature of solvent	Above 76.7°C. (170°F.)
Solvent to bark ratio	3.1 gallons per pound of dry bark

Inasmuch as benzene and the chlorinated paraffin hydrocarbons are economical and efficient solvents, it appears most practical to extract the bark first with such solvents and later to effect a separation of the hexane-soluble component. Such separation was made of the benzene extracts by means of a 5-gallon pressure vessel equipped with an agitator that resolved at 10 to 15 r.p.m. The charge of wax was placed in the vessel, and hot hexane was introduced at the bottom of the apparatus. In lieu of a filtration unit, the hot wax solution was then passed into the bottom of the empty bark extraction vessel of the extractor in Fig. 2 to allow entrained hexane-insoluble material to settle out before the solution entered the still for solvent separation. The hexane-soluble wax thus obtained had approximately the same characteristics as that resulting from direct extraction of the bark with hexane.

PROPERTIES OF THE EXTRACTED WAX

The color of the crude benzene extracted wax was light-brown to reddish-brown. The lightest-colored products were obtained from sound bark, whereas the darker-colored products were obtained from bark damaged by insects and decay. Approximately 55 to 70% of the crude benzene extracts was soluble in hexane. Sound bark yielded a wax containing the most hexane soluble component. Melting point of the benzene extracted wax was 58 to 60°C. Bark from commercial sawlogs had a benzene-soluble content usually between 5 to 10% of the oven-dry weight. Cork flakes gave the lightest-colored wax with about 66% hexane-soluble components.

Hexane-Soluble Wax

The properties of the hexane-soluble wax from different lots of bark were as follows:

Melting point	59 to 63°C.
Acid number	30 to 70
Saponification number	130 to 164
Unsaponifiables, %	18 to 30
Hanus iodine number	18 to 22

The color was yellow to light brown. The lightest-colored products were obtained from sound barks; whereas the darker products were obtained from partially decayed barks. They were nontacky and brittle when cold. When broken they presented a granular noncrystalline fracture. The specific gravity of the solid waxes was greater than 1.0; hence, they commonly separated as granular particles on cooling a hot water suspension. They could be processed into a nearly white wax with bleaching clays or by recrystallization from hot methanol. The waxes also responded to bleaching with alkaline peroxide and with sulphur dioxide. Recrystallization from methanol raised the melting point and decreased the iodine number.

The chemical composition of the hexane-soluble wax from Douglas-fir bark was found to be approximately 20% lignoceryl alcohol, 60% lignoceric acid, and 20% ferulic acid (4-hydroxy-3 methoxy-cinnamic acid). About 0.3% of the wax was phytosterol, and oleic acid was found present in small amounts (*4*).

When a hot hexane solution of the wax was cooled to 25°C., a white crystalline solid separated. It was believed to be of interest to determine the chemical composition of this insoluble fraction and of the fraction soluble in hexane at 25°C. The data are given in Table V. The free wax acid fraction was obtained by extraction with a 5% aqueous solution of potassium

Table V. Analysis of Hexane Soluble Wax Fractions

Material	Wax fraction soluble at 25°C., %	Wax fraction insoluble at 25°C., %
Volatile oil	2.7	0.0
Free wax acid fraction	29.0	43.5
Unsaturated acids	1.1	0.0
Lignoceric acid	11.1	24.3
Ferulic acid	16.8	19.2
Acid-free (neutral) fraction	66.3	49.5
Lignoceric acid	21.0	20.1
Lignoceryl alcohol	34.0	20.9
Phytosterol	0.3	0.0
Ferulic acid	10.9	8.5

carbonate. The analyses indicate that the lignoceric acid and the ferulic acid occurred in both the free and combined states.

Hexane-Insoluble (Benzene-Soluble) Wax

The hexane-insoluble wax was soluble in benzene, chlorinated hydrocarbon solvents, ethyl ether, hot acetone, and methanol. It ranged in color from a light-brown to a reddish-brown. Melting point was in the range, 60 to 63°C. Chemical constants found were: acid number approximately 74, saponification number 200 to 210, unsaponifiable matter 5 to 7%. It was dissolved by dilute alkalies to which it gave a reddish-brown color and on acidification was reprecipitated as a light tan curd. Partial crystallization was induced with acetone, but separation into simpler constituents did not materialize. This indicated that the material was relatively homogeneous.

In alcohol the material gave a black coloration with ferric chloride solution which indicated the presence of phenolic groups. A methoxyl group determination indicated the presence of 5.43% methoxyl. Methylation with dimethyl sulphate in caustic solution increased the methoxyl content to 10.2%, which indicated the presence of free hydroxyl groups. Refluxing with dilute mineral acids, followed by extraction with hexane gave about 25% of a fatty acid mixture soluble in hexane, a dark-colored phlobaphene-like residue, and glycerol in the aqueous solution. Recrystallization of the fatty acid mixture (which had a neutralization equivalent of 335) from acetone gave two fractions. One of the fractions had a melting point of 65 to 67°C. and a neutralization equivalent of 353. The other fraction had a melting point of 69 to 69.5°C. and a neutralization equivalent of 282.8, which are the properties possessed by stearic acid.

On saponification with alcoholic potassium hydroxide solution, a fatty acid mixture was obtained in about 25% yield, a dark-colored ethyl ether insoluble phlobaphene in 24% yield, an ethyl ether soluble acid fraction in 26% yield, unsaponifiable matter in 5% yield, and glycerol. Resin acids were not found and appear to be absent from this material. The hexane-insoluble wax has a more complicated chemical composition than the hexane soluble wax. The material is similar in properties to that extracted with benzene from the lignin residue obtained as a by-product from the saccharification of Douglas-fir mill waste (*3*, *5*).

DIHYDROQUERCETIN

Further extraction of wax-free (benzene extracted) Douglas-fir bark with ethyl ether produced relatively pure dihydroquercetin. The ethyl ether extract was obtained as white crystals or as a light tan powder, which melted at 228 to 230°C. It was dissolved in hot water, decolorized with activated charcoal, and then obtained as long white needles, m.p. 240 to 242°C. White needles were also obtained by recrystallization from an alcohol-benzene mixture. A mixed melting-point determination with dihydroquercetin obtained from Douglas-fir wood (*1*) gave no decrease in the melting point. On oxidation with 10% sulphuric acid in the presence of air, quercetin, m.p. 312 to 314°C. was obtained. Dihydroquercetin is absorbed by hide powder in the conventional tannin determination procedure. It also was found to combine with sheepskin skivers to give a white leather product.

TANNIN AND WAX EXTRACTION

The tannin content of Douglas-fir bark was found to range between 7.6 and 18.3% depending on the age of the trees and the position on the tree from which the bark was taken (*2*). The bark developed the maximum tannin content only after it was thoroughly air-seasoned. Leather produced with the tannin was light, even-colored, flexible, and well plumped. The bark tannin, like the tannin in Douglas-fir wood, belongs to the phlobatannin class. Tannin extracts from the bark have been produced and concentrated to 50% total solid content in this laboratory in large scale laboratory equipment without loss of tannin through conversion to insoluble phlobaphenes.

It appears that the wax-free bark residue can be used also for the production of tan liquors. Preliminary experiments have shown that the tannin content of the bark was not decreased by benzene extraction in the laboratory wax extraction unit. Also no wax appeared to be lost when the bark was first extracted with hot water for the production of tan liquors in a countercurrent extraction unit. A circumstance adversely affecting such an integrated operation is the fact that bark with the highest tannin content has the lowest amount of wax (*7*).

SUMMARY

The chief extractives of Douglas-fir bark were wax, dihydroquercetin, and tannin. The wax was extracted in a large laboratory stainless steel extractor with hot benzene. This benzene extract consists of two fractions. One fraction is soluble in hexane and is a light-colored, hard wax with a melting point of 59° to 63°C. Its chemical composition is approximately 20% lignoceryl alcohol, 60% lignoceric acid, and 20% ferulic acid. The other wax fraction has about the same melting point, but it is of a more complex chemical composition. Factors affecting the solvent extraction, such as method of grinding the bark, moisture content of the bark at time of extraction, solvent-to-bark ratio, extraction time, and solvent flow rates were investigated.

Dihydroquercetin was obtained in relatively pure form by extraction of the wax-free bark with ethyl ether. This material possesses some of the properties of Douglas-fir tannin in that it is absorbed by hide powder and combines with sheepskin skivers to give a white leather product.

An integrated wax and tannin extraction process appears feasible.

LITERATURE CITED

1. Graham, H. M., and Kurth, E. F., *Ind. Eng. Chem.* 41: 409–414 (1949).
2. Hubbard, J. K., and Kurth, E. F., *J. Am. Leather Chemists' Assoc.* 44, No. 8: 604–614 (August, 1949).
3. Kurth, E. F., *The Chemurgic Digest* 6: 366 (1947).
4. Kurth, E. F., O.F.P.L. Mimeographed Report, August 22, 1949. *J. Am. Chem. Soc.* (In press.)
5. Kurth, E. F., "Wax from Lignin Residue in Ethanol Production," presented before Northwest Section, Forest Products Research Society, May 19, 1948, Portland, Ore.
6. Kurth, E. F., Hubbard, J. K., and Humphrey, J. D., *Forest Products Research Society Proceedings* Vol. 3, 1949.
7. Kurth, E. F., Kiefer, H. J., and Hubbard, J. K., *Timberman* 49, No. 8: 130–131 (1948).

Received Nov. 7, 1949.

Magnesia-Base Sulphite Pulping

A Progress Report

R. E. BAKER and L. S. WILCOXSON

This progress report on the magnesia-base sulphite pulping process is divided into a discussion of the five main steps of the cycle: acid making, cooking, washing, evaporation, and burning. Losses are indicated, and it is expected that further progress will be made to minimize them to increase the efficiency of the process.

Previously published articles (*1, 2, 3*) have covered the history of the development of the magnesium oxide process to the point where pilot plant results quite definitely justified a commercial installation. Those publications give credit for the earlier discoveries and investigations up to and including the design and construction of the first commercial installation. It is the authors' intention to give, at this time, a progress report on the actual operation of this recovery cycle and include such facts as may be pertinent to this discussion.

For the sake of clarity, the discussion will be divided into the five main steps of the cycle in the order in which operations were started. These are acid making, cooking, washing, evaporation, and burning.

ACID MAKING

Following the furnaces are absorption towers designed to absorb the sulphur dioxide (SO_2) from the furnace gases. These towers are necessarily large since the concentration of sulphur dioxide is of the order of 1% or less and the quantity to be absorbed is approximately 360 to 400 pounds sulphur dioxide per ton of pulp produced. Three towers in series are used for each furnace. The absorbing liquor is circulated at about 1000 gallons per minute from the bottom of each tower back to the top of that same tower. This high rate of circulation is necessary since large quantities of gas are to be handled and the flow of make-up acid is relatively small. Most of the make-up water is added to the last tower and the countercurrent transfer of liquor is at system rate. Theoretically there would be sufficient quantity of sulphur dioxide from the burning of the waste liquor to react with the magnesium oxide (MgO) (make-up and recovered) to form the bisulphite salt with none or only a small quantity of the monosulphite salt. At a pH of 4 to 5 the quantity of magnesium sulphite is between 0 and 0.5%. Under these conditions the magnesium salts are in solution, and the calcium salts are in their most insoluble state. Filtration, in this case by sand gravity filters, is used to remove calcium salt picked up from the wood, make-up magnesia, etc. Following the filters the raw acid is fortified in two absorption towers (one operated up to 15 p.s.i.) with sulphur dioxide produced in a small, rotary burner.

R. E. Baker, Pulp Division, Weyerhaeuser Timber Co., Longview, Wash.
L. S. Wilcoxson, Babcock & Wilcox Co., New York, N. Y.

In order to simulate recovery conditions, sulphur dioxide gas was piped from the old acid plant into the furnace gas absorption towers to give the same quantity of sulphur dioxide in that system as would prevail when waste liquor was being burned at system rate. By operating in this manner it was possible, over a period of time, to replace all of the calcium-base liquor in the system with acid made from magnesium oxide.

In the first attempts at acid making, all of the magnesium oxide was added at the last tower in the series. It became apparent very quickly that this method could not be used since, in the reaction of magnesium oxide with sulphur dioxide, the monosulphite, which is first formed, is quite insoluble and precipitated as a scale both in the towers and piping. Also, the solubility of magnesium oxide itself is so low that the magnesium oxide slurry was a very poor absorbing medium for the sulphur dioxide. In order to overcome these difficulties, arrangements were made to add the oxide as a slurry into each of the three towers in the series. The rate of addition was controlled so that the pH at each of the towers was approximately between 4 and 5. At this pH the solubility of sulphur dioxide in the solution is very much greater and no difficulty was experienced with precipitation or scaling of the magnesium monosulphite.

In order to have more flexibility of this acid-making operation, and for the sake of better control of the acid to the filters, the vent gas from the fortifying towers was diverted to the furnace gas absorption towers. In this way it is possible, when necessary, to operate the acid making at a higher rate than that corresponding to the rate of burning of waste liquor. The acid maker can regulate the rate of sulphur burning to give the desired pH of acid going to the filters.

Early operation of this acid-making process indicated that a substantial portion of sulphates were being formed. From the pilot plant experience it was anticipated that approximately 8% of the total magnesia being recirculated in the recovery cycle would be present as magnesium sulphate, but this sulphate would build up to a maximum and be present in the system only as a dead circulating load. The formation of sulphates was quite definitely increased by the presence of excess air going to the absorption towers as well as by a fairly high prevailing temperature. Although pH had a considerable effect on the formation of sulphates, the process is, for reasons stated above, quite limited in the range of pH at which it can be operated. By the installation of heat exchangers on the recirculating liquor in the gas absorption towers, and by keeping the concentration of oxygen in the gases going to these towers as low as possible, it was possible to minimize appreciably the formation of magnesium sulphate. During the pe-

riod in which there was not complete recovery of the waste liquor, this formation of sulphates was quite critical since they were not recovered and meant the loss of that portion of sulphur and magnesia.

COOKING

Considerable changes were made to the digesters in order to facilitate the recovery of sulphur dioxide and waste liquor in this recovery process. The collector rings for the circulating systems were moved to a point just above the bottom cone so that low ratios of acid to wood could be used. Approximately one fourth of the circulating liquor (the portion depending on liquor ratio) is circulated to the bottom fitting and the remainder through a header ring and three spray nozzles at a point near the top of the dome. Indirect heaters are used in order to prevent dilution of the waste liquor with steam condensate. A low-pressure relief header with a larger digester outlet was added for the recovery of relief gases from 25 p.s.i. to nearly atmospheric digester pressure. These gases are cooled by heat exchangers and used to fortify the storage tank acid. An eductor is used which shortens the time required to relieve the digester down to 0 pressure. Approximately 20 minutes are required for this additional relief.

Rather than blowing the digesters into a conventional type of blow pit, these digesters are all connected to a common header and the stock removed by back-filling with waste liquor and pumping. The waste liquor is pumped to the suction side of the digester circulating pump and, by means of motor-operated valves at the digester fittings, the cook can divert this dilution liquor to the bottom, collector ring, or top of the digester.

It has not been possible to recover by this relief system all of the sulphur dioxide which is otherwise "flashed off" during the blowing or dumping operation. Even though the pressure at the time of dumping is very nearly 0, the static head on the digester, plus the fact that it is impossible to get good circulation at the latter part of the cooking cycle, prevents a relieving of all of the free sulphur dioxide. Figures indicate that up to 16 pounds of sulphur per ton of pulp are lost at this stage, however, it will be possible to recover this from the vents of the digester dump tanks.

In some of the earlier proposals (*4*) for the operation of the magnesium recovery system it was shown that a low ratio of acid to wood could be used and thus improve the over-all steam economy of the entire system. The consensus of opinion seems to be that ratios somewhere between $2^1/_2$ to 1 and $3^1/_2$ to 1 (based on oven-dry wood) would be practical.

Any changes in digester charges were delayed until early the summer of 1949. During the subsequent time the ratio of liquor to oven-dry wood was reduced from 5.1:1 to 4.5:1 and then further reduced it to 4.1:1. This meant a total reduction in quantity of acid pumped to each digester from approximately 31,000 gallons to 21,000 gallons. The per cent combined sulphur dioxide was increased proportionately. A considerable reduction in the steam required per digester was noted. Although the results are not conclusive, there was a material increase in the quantity of screenings produced. There were approximately three times the quantity of rejects from the knotters and it appeared that there was more variation than normal from one digester to the next, probably since the rate of circulation varied from one to another. Undoubtedly other factors influenced these results to a certain extent, and further attempts at low liquor ratio cooking are contemplated since savings in steam, both for cooking and evaporation, and savings in evaporator capacity, are so material.

As one expedient to accomplish the above results, at least to a certain extent, a procedure of using a given quantity of waste liquor with each digester charge was instituted. This waste liquor is pumped into the top of the digester after filling with chips and causes the chips to settle sufficiently to allow the further addition of approximately 1 to 1.5 air-dry tons of chips per digester. This increases the digester charge to approximately 36 air-dry tons of chips. At about 115°C. the maximum amount of side relief that is possible from the location of the side relief fittings is removed. This procedure has made it possible to obtain waste liquor solids from the washers at slightly higher concentrations than was possible with the 4.1:1 liquor ratio. The per cent solids is about 15. No deleterious effects on pulp quality have been noticed and the quantity of screenings are normal.

WASHING

As stated in the above discussion, the stock is not blown into a conventional blow pit, but pumped from the digester into unwashed stock storage tanks. Four horizontal, brick-lined, steel tanks are used as stock storage between the digesters and washers. These are connected in pairs with circulation from one to the other. During the dumping operation this stock is diluted from digester consistency down to approximately $3^1/_2\%$ air-dry consistency with waste liquor. In the original installation a "Comber" pump was used to give the same defibering action as is obtained in a normal blowing operation. This "Comber" was located in the line between the stock pump and the stock storage tanks. Experience, when operating for any appreciable length of time, both with and without this machine, indicated that no measurable benefit was obtained from it. Apparently the defibering action of the various stock pumps and agitators was sufficient to defiber all well-cooked fiber bundles.

Four Jonsson knotters, in parallel, are used preceding the acid stock washers. No attempts have been made to recover the residual waste liquor in these knots since the quantity is small. Three 8 by 16-foot stainless steel Oliver washers set in concrete vats with acid-resistant tile linings are used for washing. The piping arrangements and liquor circulating systems used in this operation are very similar to a conventional brown stock washing system normally used in a kraft mill. The temperature prevailing in the first stage washer is approximately 180°F. No vacuum pump is used.

No operating experience was available on which to base the expected performance prior to this installation. Chemical losses in the washed pulp have been somewhat higher than anticipated but it is expected that improvement can be made.

A foam tank and foam breaker were installed in anticipation of foam from the foot tanks as occurs in kraft pulp washing. However, no appreciable foaming of this liquor has been encountered, and at no time has foam carried over from the foot tanks.

EVAPORATION

For the evaporation of the liquor up to approximately 50% solids, a six-body, quintuple-effect, General American evaporator is used. Outside heat exchangers and forced circulation are used to provide high tube velocity and to cut down on heating surface required. Stainless steel or stainless clad steel construction has been used throughout this evaporation unit. The thin liquor is introduced into No. 3 effect and the flow is concurrent with the vapors through Nos. 3, 4, and 5. Following No. 5 effect the liquor is reheated back to the temperature prevailing in No. 3 effect by passing through interheaters which are small sections of the main heater segregated from the circulating flow by baffles. The flow of liquor through Nos. 2, 1B, and 1A effects is countercurrent to the vapors.

In order to prevent the loss of appreciable quantities of loosely combined sulphur dioxide during this evaporation step, it is expected to neutralize the liquor with magnesium oxide to a pH of 7.5 to 8.0 prior to introduction to the evaporators. At the present time this neutralization is not being used. The start-up of this portion of the recovery cycle was necessarily on unneutralized liquor since at that time no ash was available for neutralization. It became apparent early in this operation that considerable venting of the heater bodies was necessary to remove noncondensible gases and thus obtain adequate condensation of the vapors.

Since some difficulties with scaling of heating surfaces were anticipated, a spare heating element and circulating pump were provided. During the time that operations were at a very low rate, no appreciable quantity of scale was deposited, owing in part at least to the low temperatures prevailing in the unit. As the rate of burning increased, however, these difficulties increased. This scale formation seemed to be aggravated by abnormally high magnesium sulphate concentrations which occurred at times during the preliminary operations when the rate of burning of either liquor or sulphur was such that high quantities of excess air were admitted to the acid plant absorption system. During more recent operation, when more complete recovery has been realized and there has been a more stable operation of the entire system, the quantities of sulphates have been more uniform and at a somewhat lower value. Necessary valves for a quick "cut in" of the spare unit have been added in order to facilitate any cleaning that is necessary. During the past two months when, as pointed out previously, the per cent solids in the waste liquor have been maintained at a fairly high value for sulphite cooking, the load on the evaporators has been such that it has been possible to operate this unit quite consistently at system rate.

The waste liquor leaving the multiple-effect evaporators containing approximately 50% solids is further concentrated to about 65% solids in cascade evaporators. These cascades are located in the furnace gas stream between the multiclone separators and the gas cooling towers. The flue gas temperature drops from approximately 600°F. to about 230°F. at this step.

BURNING

Two Babcock & Wilcox furnaces are used for the actual burning and chemical recovery step in this cycle. Each boiler unit is designed for the production of steam at 650 p.s.i. and 700°F. These recovery units are of the two-drum, Sterling, extended furnace type and are equipped with gas air heaters. For the additional recovery of heat each unit is followed by a cascade evaporator and gas cooling tower. Separation of the magnesium oxide ash from the furnace gases is accomplished by the use of multiclone separators located after the air heater and preceding the cascade evaporators. These are fitted with "star" valves at the bottom discharge in order to operate against the furnace draft. The ash is conveyed by screw conveyor to a slurry tank with a portion diverted to a neutralizing tank when operating the evaporators on neutralized liquor. Make-up magnesium oxide is added to this tank, and the slurry pumped to the furnace gas sulphur dioxide absorption towers.

In the original installation six mechanically driven, integral fan oil burners were used, similar to those used in the pilot plant. However, under continuous operating conditions, considerable difficulty was experienced with baking of organic solids on the inner cup of the burner. A slight amount of this deposit would cause excessive vibration of the burner units. To overcome this difficulty, steam atomizing burners with windboxes were installed. These changes required a relocation of the burners and an increase in furnace size. With this arrangement of burners and combustion zone it has been possible to operate these units at expected capacity, producing reactive ash of good quality.

Pilot plant operation indicated that no particular difficulties would be obtained with fouling of boiler passes or tube surfaces; however, in actual continuous operation this has not proved to be true. Hand lancing has been used to keep these furnaces relatively clean and in continuous operating condition. It is expected that proper location of automatic soot blowers now being installed will insure efficient heat transfer and low draft losses.

OVER-ALL OPERATION

The problems and necessary changes as described in the foregoing have prevented, until the past two months, the recovery of substantially all of the waste liquor available. During this past two months it has been possible to collect some operating data, which, while by no means final, are indicative of the progress made to date on the recovery of chemicals and heat by this process.

A typical one-week period of mill operation with fairly uniform conditions throughout was August 16–22, inclusive. The following results of recovery operation were obtained:

Make-up sulphur per air-dry unbleached ton	103
Make-up magnesium oxide per air-dry unbleached ton	49
Make-up magnesium oxide (corrected to 100% MgO) per air-dry ton	44

With the quantity of magnesium sulphate normally present in this acid, use of 100% magnesium oxide and sulphur with no recovery is approximately 170 pounds and 285 pounds per ton, respectively. On this basis, 74% recovery of the magnesium oxide and 64% recovery of the sulphur is obtained. If the above figures are corrected for small changes in liquor inventories, the actual make-up of magnesium oxide becomes 42 pounds per ton and of sulphur becomes 100 pounds per ton.

Certain losses of both sulphur and magnesium oxide during this period were determined. These were as follows:

Losses—Pounds Per Ton

	MgO	*Sulphur*
Dump tank vents	..	10
In pulp after washers	13	22
Knotter rejects	1	2
Evaporator condensates	9	24
In furnace (as build-up in passes and on surfaces)	6	?
Acid plant filters	5	11
Total	34	69
Unaccounted for	8	31

Included in those quantities unaccounted for would be quantities lost in leaks at various pump glands, losses through sampling, and losses, primarily of sulphur, from venting of noncondensible gases from the evaporators.

During this period a total of 2130 pounds of solids per ton of pulp produced was fired in the furnaces. Average per cent solids in the liquor as fired was 62.7 as measured by the hydrometer method. This total solids per ton available for firing could be corrected to 2185 if allowance is made for liquor inventory changes. The net B.t.u. production in the steam from the recovery boiler was 4340 B.t.u. per pound of liquor solids fired; 430 B.t.u. per pound of liquor solids were further recovered in the cooling towers. One thousand B.t.u. per pound of liquor solids are used in evaporating water from the liquor as delivered to the recovery unit. Thus a total of 5770 B.t.u. per pound of liquor solids are expended in useful work. Average B.t.u. value of this waste liquor is 7210 per pound of solids.

While the data given above are some of the first results from the operation of this recovery cycle, they indicate that further progress in recovery of chemicals and organic materials will be made as the losses described are minimized. It is, however, impossible to predict at this time the final recovery that will prove practical. Steps are being made now to recover some of these losses. When the recovery operation has been over sufficient time to be more conclusive and more data are available, the authors intend to publish a more complete and technical report to show the performance to be expected.

LITERATURE CITED

1. Tomlinson, G. H., and Wilcoxson, L. S., *Paper Trade J.* 110, No. 15: 31–38 (April 11, 1940).
2. Hatch, R. S., *Paper Trade J.* 122, No. 11: 54–56 (March 14, 1946).
3. Anon., *Pulp and Paper* 22, No. 12: 38–46 (Nov., 1948).
4. Palmrose, G. V., U. S. pat., 2,192,239 (March 5, 1940).

Received Oct. 14, 1949. Presented at the Fall Meeting of the Technical Association of the Pulp and Paper Industry, Portland, Ore., Sept. 12–15, 1949.

The Beta-Ray Basis Weight Gage

E. A. CRAWFORD and M. STRAIN

A description is given of a recording indicator utilizing a radioactive isotope for the measurement of basis weight on paperboard. Experiments show that using a radioactive source actuating a detector, the response was directly proportional to the intensity of the radiation. When consecutive layers of material of uniform density are interposed between the ray source and the detector, the intensity of the beam diminishes as a function of the thickness of the sheet. Beta rays are used because they are less hazardous to health and provide a steady source of energy. No Geiger tubes are required. The unit is mounted on the machine after the calender stack to measure paperboard continuously, and the recorder can be so adjusted that lights will appear when the weight tolerance is exceeded.

Although the much prophesied and eagerly awaited use of atomic energy as a source of power for industrial and domestic use has not yet become a reality, atomic energy in minute quantities is now available in the form of radioactive isotopes produced in the atomic pile at Oak Ridge. Some of these isotopes are ideally suited to instrument and control needs because the radiation emitted from them is substantially constant, particularly in the case of strontium 90 which still retains half of its original strength of emission after 25 years.

It is of particular interest to the paper industry to note that the first permanent installation of a recording indicator utilizing one of these radioactive isotopes was made in the paper industry at the Continental Paper Co. of Ridgefield Park, N. J. This device is employed to give a continuous indication and recording of the standard basis weight of finished paperboard.

Although frequent spot sampling and statistical control methods have been employed with a fair degree of success, these methods do not compare favorably with a continuous, automatic, nondestructive indication and recording of the weight of paperboard for maintaining the desired quality control of the product. This is true of nearly any continuous process, but applies particularly in the paper industry when rolls are being made, since usual sampling methods permit checking only at the beginning and at the end of each roll.

In an ideal system for measuring weight of paperboard, the following features are desirable: (1) contact with the paperboard to be avoided because the surface is easily marked; (2) accuracy of measurement to be equal to or better than present commercial methods of weighing; (3) equipment to be sturdy, reliable, and stable; (4) equipment to be simple in operation and direct reading; (5) cost of equipment to be nominal; (6) safe for use by any personnel in manufacturing area; (7) continuous recorder for weight to be provided; (8) periodic automatic reset and calibration to

E. A. Crawford, Engineering Supervisor, and M. Strain, Research and Control Engineer, Continental Paper Co., Ridgefield Park, N. J.

Radio isotopes used were obtained on allocation from the U. S. Atomic Energy Commission.

be provided to compensate for temperature effect of equipment or other variables.

When the material is accessible from two sides, as is the case for paperboard, a method employing absorption of radiation is usually employed because changes occurring in the radiation upon penetration through the material are easily measured. Since x-rays have been used previously in measuring mass without contact with the material, and recently more accurate and stable instruments for measuring radiation have been developed, it would seem logical that an instrument using radiation would be best suited for measuring the weight of paperboard. Also, the recent development of radioisotopes has made it possible to have a stable and reliable source of radiation at a reasonable cost. Several isotopes are available which radiate different types of rays, and therefore it is possible to select a ray which has sufficient energy for penetration of mass without being hazardous to people working nearby.

Consider the types of radiation available, for example, alpha particles, beta, gamma, and x-rays. For practical use, alpha particles are too limited in range and so are applicable only for measuring very thin materials which can be accomplished with equal accuracy by low energy beta radiation. Gamma rays and x-rays are far more penetrating; although they are suitable for measuring great masses or thicknesses of several inches of steel or concrete, they are hazardous unless safety procedures and protective equipment are used, and also are poorly suited for measuring very thin materials with comparative accuracy because of the extremely penetrating nature of the radiation. Even very low energy gamma and x-rays suffer little or no change upon transmission through a thin sheet of plastic fiber or paper. Other undesirable factors are the high cost of equipment, replacement cost, short life, and in the case of x-ray, nonuniformity in the intensity of emission.

Radioisotopes are now obtainable which emit either beta or gamma rays of selectable energies, or any combination of the two. Wherever beta rays can be used, the beta-ray isotope is more desirable because not only is it less hazardous but also it has greater ionizing ability requiring less activity for equal ion-chamber response. Beta rays emerging from a radioactive source possess a continuous spectrum of energies. The intensity of beta rays emitted from any source is usually stated in millions of electron volts maximum energy, which is always considerably greater than the average value.

Experiments show that a radioactive source actuates a detector with response directly proportional to the intensity of the radiation incident upon its window. When consecutive layers of a material of uniform density are interposed between the beta source and the detector, it will be found that the emerging beam intensity and detector response diminishes in an exponential fashion as a function of thickness of the absorber.

The penetration qualities of beta rays are shown in Fig. 1 which is a graph of the total weight per unit area of absorber material in grams per square centimeter (*Rm*) required to stop completely the beta radiation, and (*Em*) the maximum energy of the rays at the source in millions of electron volts. The range of weights shown includes a wide variety of industrial materials such as paper, paperboard, textiles, plastics, films, and metallic sheets. For each particular application the choice of isotopes depends primarily upon the maximum weight per area to be measured by the instrument remembering that the ideal isotope is that which generates the greatest ionization in the chamber and provides the steepest and most linear section of its absorption characteristic over the range of weight per area to be covered.

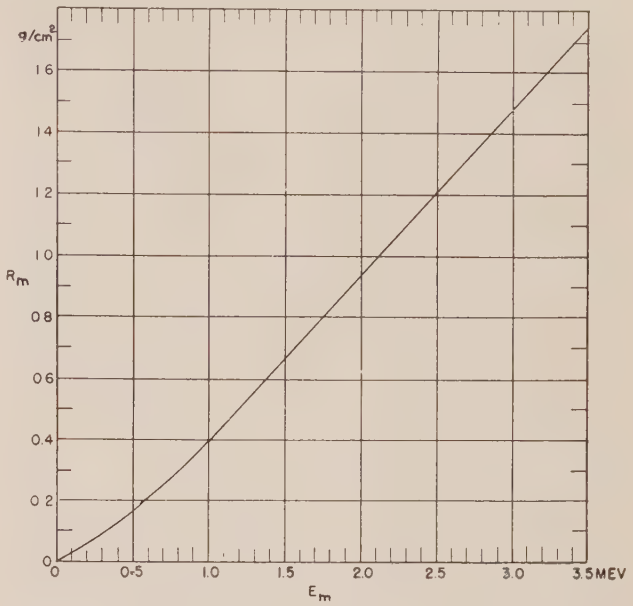


Fig. 1

Using a properly selected beta-ray isotope and a fixed arrangement of equipment (and this is an important point) the absorption curve of beam intensity versus weight per unit area of absorber is essentially the same for any absorber material. The reason is that the mass required to stop a beta ray is independent of the nature of the absorber because the number of electrons in a specific mass of material is substantially independent of the nature of the material. Therefore this principle is ideal for measurement of weight per unit area and will indicate thickness of the area only if the density of the material remains constant. Weighing instruments using radioisotopes employ the principle that radiation from a radioactive substance undergoes reduction in intensity upon penetrating the material being measured, and that the degree of absorption of nuclear radiation by any material is a function of the total mass between a radiation source and a detector.

The type of detector used is important in that it should be stable and have a long useful life. This eliminates Geiger tubes and others of similar type. Consequently, ionization chambers which are subject to none of the above limitations have been chosen as the radiation-sensitive element. An ion-chamber is a sealed cavity containing air at atmospheric pressure and equipped with two electrodes of opposite electrical potential. Upon irradiation the ions developed are caused to drift to the collecting electrodes, thereby causing a small current to flow which can be measured directly by an electrometer or amplified to operate a meter or recorder.

A complete instrument including a basic electrometer arrangement, as that developed by Tracerlab, Inc., designed for continuous production service, consists of an ionization chamber and source which are supported on a U-shaped bracket which in turn is mounted on the machine at any selected location after the presses. The paperboard flows between the source and the chamber and the weight per unit area is directly indicated and charted by a recorder. Tolerance relays within the recorder can be adjusted so that flashing red or green lights will appear when a positive or negative weight tolerance is exceeded. Other terminals are provided for auxiliary warning or control equipment.

The recorder used is a self-balancing potentiometer type making use of automatic standardization which closes the main radiation source momentarily by blocking it with a heavy absorber so that it cannot affect the ionization chamber. At the same time a small standard source identical in nature to the main source, but located within the chamber element, is automatically permitted to energize the chamber. Simultaneously, mechanical switching within the recorder permits the standardization potentiometer to be adjusted to match that of the irradiation of the chamber caused by the standard source. By this operation which occurs every half hour for several seconds, the instrument automatically corrects for variation in voltage and electronic components.

Other features of the equipment are: the radioactive source material is fused into a ceramic; it is firmly fastened and sealed to eliminate health hazards associated with body or air contamination; and the ionization chamber is situated above the source mount so that the rays are cast upward directly into the chamber, and the source is equipped with a flag indicating the presence of radiation whenever the shutter is open. In order to exceed radiation tolerance limits, it would be necessary for a man to stay within 6 inches of the source 8 hours per day.

In the first industrial application of this type of instrument which it is of interest to note was made in a paper mill, the unit is used to measure paperboard continuously as it leaves the calenders. The source and ion chamber are mounted between a rider roll and the slitter because at this point the paperboard always passes through the same path, regardless of the number of calender stacks used. Because of the small size of the detecting equipment, it was easily installed in this limited space and does not interfere with the normal operation of the machine. This location also facilitated running a series of tests to determine the accuracy of the instrument because immediately following the slitters is the cutter where normal production requires that a continuous spot-checking be made. The recorder is located in full view of the personnel making the spot checks.

The routine spot-checking procedure (with regard to weight) requires that two sample sheets, each 1 square foot in size, be weighed on balance-type scales and that the operation of the machine be controlled to maintain the weight within the specifications for the board being made. The scales are calibrated to read directly both in pounds per thousand square feet and in regular basis weight. The calibrations on the indicator scale of the instrument are in "regular" basis weight. The instrument is provided with two ranges: from basis 20 to 70, and from 60 to 110. The overlapping of the two ranges permits variations in weight to be indicated without changing from range to range when board is being produced in the range of 60 to 70 basis weight.

The scale on the recorder chart is linear and corresponds to weight per unit area (W) and can be converted to basis weight (B) by the formula $B = 7287/W$ or read by use of a transparent scale calibrated the same as the indicator scale placed over the chart. It is probable that in the future the charts will be printed with the basis weight scale, so that both the chart and the indicator scale will be in terms of basis weight.

Immediately after the installation of the beta gage, samples were taken to check the calibration of each range. The initial 20 spot checks made during the first two weeks agreed with the recorded weight of the recorder. During this period of time the unit was recording weights ranging from 202 to 73 pounds per 1000 square feet which is equal to basis 36 to 100. Since that time an additional 500 samples have been taken, all of which have agreed with the recorded weight. Also, several hundred additional samples have been checked by the backtenders during their routine checks for weight and caliper.

One deviation, which is not an error, has been found. It was expected that an apparent error in the calibration of the beta gage would occur when weighing paperboard having a water finish applied at the calenders because of the moisture-laden air surrounding the paperboard immediately after leaving the calenders. However, the saturation point for the air holds this value constant at approximately 1 pound per 1000 square feet of paperboard, and therefore the amount of error is small for the weight of paperboard normally produced on this machine. On lightweight board, however, it would make as much as 1 pound basis weight difference. To date an adjustment in calibration has not been necessary to meet this condition. Instead, it has been merely noted that when a water finish is used the beta gage reads heavy by approximately 1 pound per 1000 square feet.

In general the results in the use of this instrument have been most satisfactory. Mill tests of the instrument in checking its accuracy have shown it to be more accurate than necessary for production. The recording part of the instrument is of value in showing trends or small drifts in the weight of the board which are not discernible with normal checking procedure. Based on an analysis of the problem and principles upon which the equipment is designed during the past 18 months since the authors started working with the unit, and on experience first with a pilot model about a year ago and for a few months with the completed commercial model, the authors believe that the device is a reliable and accurate means for determining mass per unit area, and in paper production, will prove to be a valuable tool in detecting process variations in time to correct them before they have gone too far, thus maintaining uniformity of product.

Received Sept. 20, 1949. Presented at the Fourth Engineering Conference sponsored by the Technical Association of the Pulp & Paper Industry, Boston, Mass., Oct. 31, Nov. 1-3, 1949.

Revolving Disk Mills in Straw Pulp Production

C. K. TEXTOR and L. E. EBERHARDT

Laboratory data are given on the processing of straw with disk mills. Confirmation by commercial experience is indicated but without supporting evidence. Laboratory size units give but a rough correlation between trial and commercial results but it is believed that the experimental use of full-scale equipment will provide an adequate basis for guaranteeing performance.

On the basis of experimental evidence as well as through actual mill experience, revolving disk mills, of both the "single-disk" and "double-disk" varieties, have proved well adapted to economical and improved procedures in the production of straw pulp for building board, container board, and for fine papers. The procedures and results described in this paper are confined to experimental laboratory investigations, some of which have been confirmed by commercial experience.

Revolving disk mills are offered in many modifications, but all of them fall into two general classes, depending on whether only one, or both, of the disks are rotated. There are certain similarities in the operation and in the results obtained with the two types of mills; there are also radical differences. There is no science and no reliable rule-of-thumb methods to serve as a basis for choosing between the two types of revolving disk mills or between the many methods of application. The only reliable means to determine what type of mill and what method is to be preferred is by actual trial of both types under various methods of operating on a specific raw material in the preparation of fiber of a desired quality.

While there are no simple formulas for specifying the most suitable mill, there are, nonetheless, some general observations which are correct most of the time. For example, to obtain highest mechanical efficiency and optimum quality of product all disk mills must be fed with raw material at a uniform rate and at a uniform consistency. And as the optimum consistency of feed frequently has been found to fall in the range of 8 to 12% the problem of properly feeding a refiner becomes a major consideration. This is especially true with straw. There are no mechanical feeders available which are adequate for the effective rate of flow regulation of cooked or uncooked straw to a disk mill, and so indirect means of feed control must be employed. Commonly used for this purpose is a procedure involving the pumping of the cooked straw at uniform consistency to a headbox where the rate of flow is controlled through an adjustable orifice and the insertion of a dewatering apparatus for consistency control between the headbox and the refiner.

Another general observation is that there is less tendency for the stock to discharge rapidly from between the plates of a double-disk mill as compared with the single-disk design. This is doubtless due to the probability that the expelling effect caused by the rotation of one disk is, in part, offset by the counter-rotation of the opposite disk. Perhaps for this reason it has been found easier to accomplish thorough refining by a single pass through a double-disk mill than can be achieved when only one disk is revolving.

On the other hand, it is easier to feed long stringy material to a properly chosen single-disk unit than to a double-disk mill. When cooked straw contains a considerable proportion of long, tough stems ranging from 6 inches to a foot long, they have a tendency to wind upon the shaft and spokes of a double-disk mill and eventually shut off the feed.

Of the many applications of disk refiners in straw mills the simplest is that in which conventionally cooked straw is processed through a disk mill rather than through the beaters, jordans, and other refiners previously used. This application has been investigated on a laboratory basis, and the results have later been confirmed in commercial installations.

In a typical test along these lines a large sample of straw cooked by a regular mill procedure was available for investigation. Also available was some of the same straw as processed through the conventional beaters and jordans in that mill. This mill-cooked straw, after refining by the existing mill equipment, had a freeness of 310 ml. Canadian Standard, a bursting strength of 35%, and a tearing resistance of 80%. It produced a merchantable corrugating medium.

The same cooked straw, processed through a 300-hp. double-disk pulper at 10% consistency and at a rate of 75 tons (air dry), per day, produced a pulp which was slightly (perhaps about 5%) above the mill-prepared stock in burst, tear, and stiffness, but was 40 ml. freer and indicated a node content of not over 50% of that in the mill-prepared stock.

In a similar test in which the mill cook was rather mild the cooked straw reached the laboratory containing numerous long, tough strings which caused trouble in feeding to the double-disk refiner. This difficulty included both the winding up of the long strings on the shaft of the disk mill and trouble in regulating the rate of flow to the refiner. A refining trial with a single-disk mill overcame the difficulty incident to the uncut straw, but the regulation continued to be poor and the quality of the refining left much to be desired. The problem was solved by the use of a two-pass operation. The first pass was through a single-disk mill equipped with devil-tooth plates. This was considered primarily a break-down operation, and as the flow of stock to the mill was difficult, no attempt was made to control the rate of feed or the consistency of feed. This light break-down treatment consumed only about one half horsepower per ton per day.

The discharge from the single-disk mill was in excellent condition for controlled refining in a second

C. K. Textor and L. E. Eberhardt, Members TAPPI, Bauer Brothers Co., Springfield, Ohio.

pass. All of the long strands were thoroughly broken up, but the resultant materials were very free for dewatering operations and were easy to pump. The second-pass operation was conducted with a double-disk mill whose product was essentially the same as that above reported, that is, it had a freeness of about 350 ml. Canadian Standard, a bursting strength of about 35%, a tearing resistance of about 80%, and a stiffness adequate for manufacture into satisfactory 9-point board.

An interesting modification of the simple installation of a double-disk mill in straw pulp production comprised a test made on cooked straw which, before refining, had been processed through a sugar mill or cane crusher. After refining through a 300-hp. double-disk mill at the rate of 90 tons per day, this straw pulp had a freeness of 430 ml. Canadian Standard, a bursting strength of 50%, and a tearing resistance of 90%. The node content of the product was approximately the same as that in the previously described pulps prepared by double-disk refining. As compared with conventionally cooked straw, this straw, refined after sugar mill treatment, had 43% more bursting strength, 12.5% more tearing strength, and was 120 ml. higher in freeness.

When this same pulp was refined at the rate of 60 tons per day, the product was equally impressive. Compared with the straw pulp that was being successfully used in another mill, this pulp was 60% stronger in burst, had 18% more tear, was 50 ml. freer, and had a stiffness test at least equal to that of the commercially produced sheet.

It is only fair to note that the comparisons described above were made on pulps from different localities, and data are incomplete concerning the comparative quality of the raw straws available to the several plants and the cooking conditions.

Another investigation involved the use of disk mills combined with cooking at atmospheric pressure. The results of this research were very promising though only a few tests were conducted, and no effort was made to determine such optimums as the amount or concentration of chemicals, the time or temperature of steaming, or other processing features.

Typical of these tests was one in which a regulated flow of chopped straw was fed to a single-disk pulper equipped with devil-tooth plates. At the same time, a stream of concentrated (150 grams per liter) caustic soda (NaOH) was added to the straw immediately ahead of the disk mill in such quantity that 10 pounds of caustic were used for each 100 pounds of dry straw. This procedure insures intimate mixing of a small volume of liquid with a large volume of straw.

This caustic soaked straw was then held in a container, and its temperature raised gradually to about 200°F. during a period of about 60 minutes, and then held at that temperature for another hour. At the end of this hot-soaking period, the mass, without washing, was reprocessed through a double-disk mill with flat plates, adding water to achieve a refining consistency of about 15%. The refined pulp was washed after refining.

While this investigation was conducted in the laboratory as a batch procedure it is visualized for commercial interpretation as a continuous process from the straw chopper to the finished pulp. In such modification the digesting equipment would consist of a tower or a rotating cylinder so arranged as to hold stock for the desired interval while feeding into and discharging from it at a uniform rate.

A few variations in this procedure were briefly investigated, such as the use of a weaker solution of caustic soda (50 grams per liter), and that of washing the straw before the second-pass refining. No profound differences incident to these minor changes were disclosed in these rather sketchy tests.

The pulp produced in these investigations was substantially lighter in color than the conventionally cooked straw pulp intended for 9-point board manufacturing, and with the mechanical refining treatment which the pulp was given, it turned out slower and stronger than the typical strawboard pulps described above. The typical freeness of these pulps was 200 ml. with a burst test of 70% and a tearing test of 70%. The nodes were not eliminated although there were definitely fewer than in conventional straw pulp. The nodes were relatively large and possibly could be removed by screening although this point was not investigated.

A typical power consumption in this series of tests was the use of 2.5 hp. per ton per day in the first pass and approximately 7 hp. in the second pass. These figures, converted into practical mill considerations, indicate that a train of equipment comprising a hot-soaking tower of adequate size preceded by a 100-hp. single-disk mill and followed by a 300-hp. double-disk mill would have a daily capacity of 40 tons of pulp.

As previously noted, all of the data presented in this paper were derived from laboratory tests in which full commercial size disk mills were involved. As in the case of beaters, jordans, and rod mills, minature disk mills do not give the same refining as the large mill. However, it was found that an 8-inch disk mill can be used after the same fashion that a laboratory beater is employed for small-scale preliminary tests, and that a rough correlation between the results of the miniature disk mill and a full commercial size mill can be established.

For the most part, the papermaking qualities of the pulps produced in the laboratory were estimated on a basis of handsheets produced by conventional methods. Fortunately, the data obtainable from handsheets, together with freeness and similar data, are reasonably good indices of the quality of product which can be made on a commercial paper machine from a given refined pulp.

While it is believed that there is no substitute for actual commercial operation in the final proving of a process, it is believed that the laboratory procedure described above, involving full-scale refining equipment, will solve upward of 90% of the problems remaining after miniature scale research has been completed. Such laboratory findings provide an adequate basis for guaranteeing the refining performance of a disk mill, and it is believed that processes, which show promising results on the semicommercial laboratory basis, will have at least a reasonable chance for proving successful on a commercial production scale.

Received Feb. 14, 1950. Presented at the meeting of the TAPPI Fibrous Agricultural Residues Committee, Terre Haute, Ind., Nov. 7–8, 1949.

Recovery of Waste Heat in Pulp and Paper Mills

D. K. DEAN

The possibilities of recovering heat from various pulp and paper mill operations and the equipment needed are discussed. Four types of blowdown recovery systems are outlined. In the sulphite process sulphur dioxide can also be reclaimed. Appreciable amounts of heat can be obtained from digester relief, in deinking plants, and from the paper machine room. The application of the steam accumulator is considered.

As ONE approaches a pulp mill, particularly on the leeward side, the great clouds of steam and vapors released into the air and lost wherever a digester is blown, are evidences of the possibilities of appreciable recoveries of heat.

In sulphate and soda mills there is a demand for heated water at temperatures on the order of 150°F. for pulp washing, and it so happens that the amount of heat recoverable from released digester blow steam will, in many cases, just about supply this demand.

In sulphite mills, however, this requirement generally is absent. There is, however, a possibility of recovering sulphur dioxide released with the blow steam. Indications are that the value of the sulphur dioxide recovered will make the installation of a recovery system economical and at the same time, abate a nuisance.

The possibilities of heat recovery from digester blow steam can be shown by assuming a mill having three digesters each having a volume of 2550 cubic feet and a capacity of $6^2/_3$ tons of pulp per charge, and relieving from the cooking pressure of 100 p.s.i. gage. Assuming a cycle for each digester of 4.8 hours, there would be a total of 15 blows per day with an output of 100 tons per day.

With chips containing 40% cellulose and 42% moisture, and a water equivalent of 42 pounds per cubic foot, the water equivalent of each digester would be $2550 \times 42 = 107{,}100$ pounds.

From the steam tables:

Enthalpy of water at 100 p.s.i. gage	=	308.07 B.t.u. per pound
Enthalpy of water at atmospheric gage pressure	=	180.07 B.t.u. per pound
Heat released per pound of water equivalent	=	128.00 B.t.u. per pound
Heat released per blow = 107,100 × 128	=	13,708,800 B.t.u.
With a latent heat of vaporization	=	970
Steam released per blow = $\frac{13{,}708{,}800}{970}$	=	14,150 pounds

With a blow period of 8 minutes, the average rate of steam release during a blow would be $14{,}150 \times \frac{60}{8} = 106{,}125$ pounds per hour.

However, during a digester blow the maximum rate of heat release takes place at the start when the blow valve is fully opened. This maximum rate of heat release is about 75% greater than the average rate. Hence, equipment designed to condense the steam flashed under these assumptions should have a maximum condensing rate of $1.75 \times 106{,}125 = 186{,}000$ pounds per hour.

In the condensation of 14,150 pounds of steam per blow with condensate cooled to 125° and assuming losses of about 10%, the heat which may be recovered per blow would be $14{,}150 \times 1057.5 \times 0.9 = 13{,}467{,}000$ B.t.u. The heat which might be recovered in 15 blows corresponding to a 24-hour operation would be $15 \times 13{,}467{,}000 = 202{,}005{,}000$ B.t.u. per day. This is sufficient to heat water continuously at the rate of about 210 g.p.m. from 70 to 150°F.

Since digester blowdown is intermittent for relatively short periods and usage of hot water is generally continuous, water storage must be provided to store the heated water for use between blows, and to insure that a supply of cool condensing water is always available for succeeding blows.

BLOWDOWN RECOVERY SYSTEMS

There are four types of heat-recovery systems used for condensing digester blowdown steam and transferring the heat to wash water. Each system has been used successfully by sulphate or soda pulp mills. If proper care is taken in evaluating the advantages and disadvantages of each system the mill operators should be able to select the one best suited for their particular mill.

Direct Contact System

This system consists of a direct contact condenser, water circulating pump, accumulator tank, and water regulating valves. Blow steam passes into the condenser where it is condensed by direct contact with wash water pumped from the bottom of the accumulator tank. The heated water drops into the top of the accumulator tank from which it is pumped to the washers or diffusers. The temperature of the water is maintained constant by means of a thermostatically controlled water regulating valve on the inlet line to the condenser. Cold wash water is admitted to the bottom of the accumulator tank by means of a float operated valve. The accumulator tank provides a reserve of wash water so that the condenser can be supplied with water as needed to condense the blow steam.

This system has four distinct advantages: (1) simplicity of equipment and operation, (2) low first cost, (3) low maintenance since there are no heating surfaces to clean or replace, and (4) flexibility in varying wash water temperature or increasing duty.

There is one disadvantage, however, in that the wash water will become contaminated to a varying degree with black liquor and odorous sulphur compounds. This fact has excluded the direct contact system from

D. K. DEAN, Manager, Industrial Div., Foster Wheeler Corp., New York, N. Y.

serious consideration in many mills. Nevertheless, at least one soda mill and one sulphate mill are using this method of heat recovery successfully.

In general, it is believed that this system might work to better advantage in soda mills where odorous sulphur compounds are not encountered.

Surface Condenser System

This system consists of a shell and tube type condenser with sufficient surface to condense the peak release of steam, a water circulating pump, accumulator tank, and water regulating valves.

The blow steam passes into the condenser where it is condensed on the tubes cooled by wash water pumped through the tubes from the bottom of the accumulator. The heated water passes to the top of the accumulator tank from which it is taken off to the washers or diffusers. The temperature of the wash water is regulated by a valve on the inlet line to the condenser. Cold wash water is admitted to the bottom of the accumulator tank by means of a float valve.

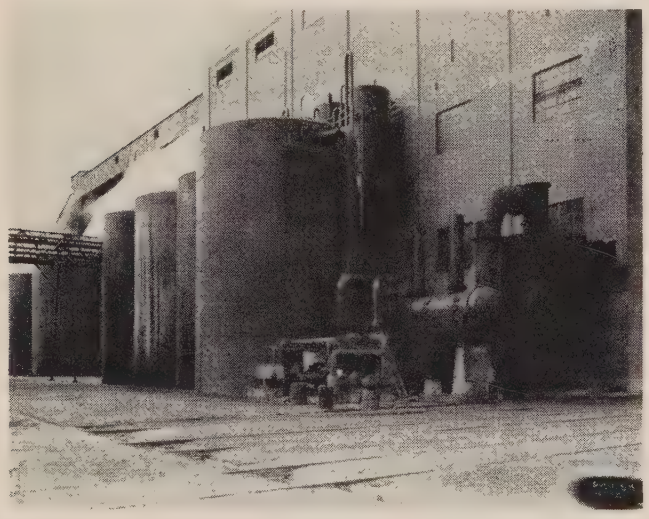


Fig. 1. Digester blowdown surface condenser

This system has two distinct advantages: (1) simplicity of equipment, and (2) it provides clean, hot wash water.

It has four disadvantages: (1) less heat recovery since blow steam condensate will leave the condenser at about 212°F. while in other types the condensate is cooled to about 125°F. This difference in condensate cooling represents a loss of about 9% of the heat available for recovery. (2) The tube bundle is apt to become plugged with pulp if carry-over from blow system should be high. (3) If wash water contains scale-forming material, the tubes will scale rapidly. (4) If wash water contains dissolved gases, steel tubes will corrode rapidly.

These disadvantages are serious but in considering them, all factors should be weighed. For instance, the reduced heat recovery may not be objectionable if all of the heat available is not required for wash water. The condenser can be designed to prevent plugging of the tube bundle with pulp for normal amounts of carry-over. One method of accomplishing this is to introduce the steam in a baffled opening below the condensing tube bundles. As the steam rises and is condensed on the cooling surface, the condensate falls back over the tubes and washes the cooling surface free from particles of pulp. Scale formation can be retarded greatly, and corrosion can be eliminated by using stainless steel tubes although this is expensive. Normally, steel tubes subject to corrosion of the blow steam only, will last about four to five years in a sulphate mill.

Generally, more care should be taken in selecting this type of system than with any of the others. It is necessary to check the wash water requirements, the blow system, and analyze the wash water before arriving at a decision. (Fig. 1.)

Liquid to Liquid System

This system consists of a direct contact condenser, a water circulating pump, accumulator tank, condenser water regulating valve, surface type heat exchanger, hot water circulating pump, and temperature control valve.

Two separate cycles are involved. First, the digester blow steam is condensed intermittently in the direct contact condenser. The water flow is regulated so that the water leaving the condenser is at a temperature of about 205°F. The heated water passes into the top of the accumulator tank, and the colder water for the condenser is pumped from the bottom similarly to the other systems. In this case, however, fresh water is not added to the accumulator and the water is recirculated continuously. The excess water due to steam condensate is overflowed to waste by means of a loop seal from the bottom of the tank. Second, the hot, contaminated water is withdrawn at a continuous rate from the top of the accumulator and pumped through a series of heat exchangers. Fresh wash water passes through the other side of the heat exchangers and is heated to about 150°F. The hot water is controlled by a temperature regulating valve to maintain a constant wash water temperature. The hot water is cooled to about 125°F. and returned to the bottom of the accumulator tank where it is stored for condensing the next digester blow.

This system has three advantages: (1) it provides clean, hot wash water; (2) it requires less surface for transfer of heat than the surface condenser system; and (3) it recovers more heat than the surface condenser system.

It has three disadvantages: (1) heating surfaces are apt to become plugged with pulp; (2) heating surfaces may scale on both sides if water is scale forming; (3) corrosion may be experienced due to dissolved gases if heating surfaces are made of carbon steel.

Here again, by using stainless steel heating surfaces, scale formation can be reduced and corrosion eliminated. Stainless steel surfaces will also reduce the tendency for pulp particles to plug the heat exchangers as the surfaces will not rust and form rough spots to which the pulp particles can adhere.

Vapor to Liquid System

This system (Fig. 2) consists of essentially the same equipment as the liquid to liquid system, except that the heat exchanger is a vapor to liquid type and, in addition, has two steam jet air ejectors with a common after condenser.

As in the liquid to liquid system, two separate cycles of operation are involved. The first is exactly the same

as described, while the second differs. The hot contaminated water is withdrawn at a continuous rate from the top of the accumulator tank and passes by gravity into the first stage of the vapor heater. This stage is under a vacuum of about 19 inches Hg corresponding to about 165°F. saturated temperature. The entering water being at 205°F. gives up its sensible heat, or flashes, and the flashed vapor is condensed on a tube bundle with fresh water inside the tubes. The contaminated water passes by gravity to the second stage of the vapor heater. This stage is under a vacuum of about 26 inches Hg corresponding to about 125°F. saturated temperature.

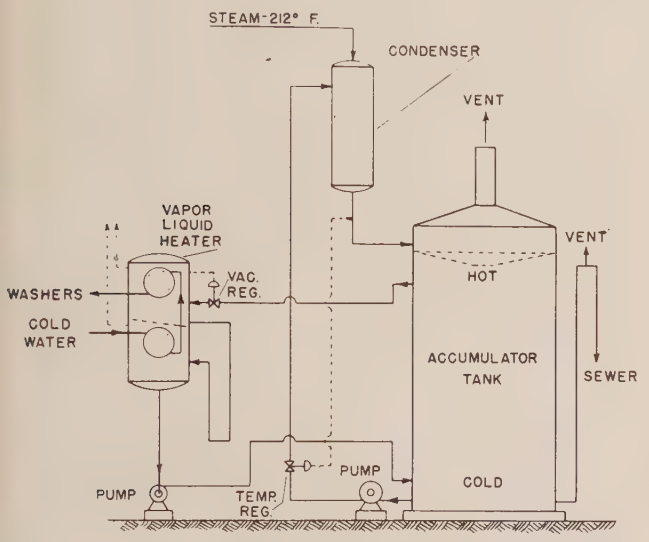


Fig. 2. Vapor to liquid system

Entering water at 165°F. flashes again and the resultant steam is condensed on a second tube bundle with fresh water inside the tubes. The contaminated water is removed from the bottom of the second stage by means of a pump and is returned to the bottom of the accumulator tank. Vacua are maintained by small steam jet air ejectors, one for each stage. The flow of water from the accumulator tank to the heater is controlled by a vacuum regulator set to maintain a constant vacuum in the first stage of the heater. The fresh water enters the lower tube bundle in the second stage and leaves the upper tube bundle in the first stage. Since the vapor temperature will be held constant in the first stage of the operation the fresh water leaving this stage will be at a constant temperature.

This system has four advantages: (1) it provides clean, hot wash water; (2) it requires less surface for transfer of heat than the surface condenser system; (3) it recovers more heat than the surface condenser system; and (4) the heating surface cannot become plugged with pulp because contaminated water does not contact the tubes.

It has two disadvantages: (1) the heating surfaces may scale up on the fresh water side if this water is scale-forming; (2) corrosion may be experienced due to dissolved gases if the heating surfaces are made of carbon steel.

The use of stainless steel surfaces will reduce scale formation and eliminate corrosion (Fig. 3).

The comparative costs of the four heat recovery systems running from low to high, would be about as follows: (1) direct contact, (2) liquid to liquid, (3) surface condenser, and (4) vapor to liquid. If stainless-steel heating surfaces are used the comparative costs would be about the same except that the vapor to liquid system would go into third place and the surface condenser system would drop into fourth place because of the large surface required for the condenser.

RECOVERY OF DIGESTER RELIEF STEAM

Another saving of heat in alkaline pulp mills, as in sulphite mills, is in the recovery of digester relief either by condensing the steam in an accumulator for heating a liquor charge for subsequent use, as is customary in sulphite mills, or by the heating of wash water.

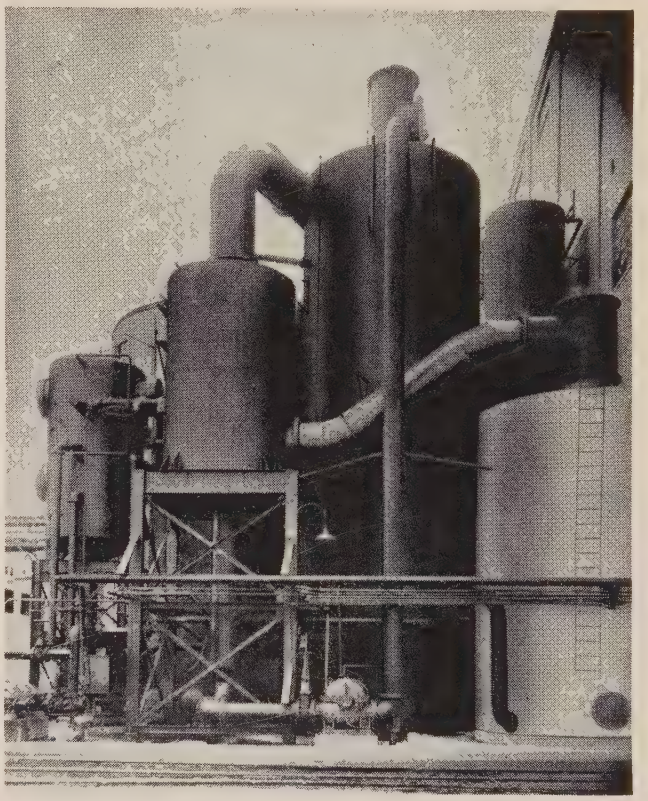


Fig. 3. Vapor-liquid blowdown recovery system

In kraft mills handling resinous pulp wood, appreciable amounts of turpentine may be recovered by condensation with the relief steam. From $2^1/_2$ to 4 gallons of sulphate turpentine per ton of pulp may be recovered from southern pine and lesser amounts from northern resinous species.

Figure 4 shows the arrangement of a turpentine recovery system consisting of a separator for pulp and liquor entrainment removal, a condenser, and a decanter for the gravity separation of the turpentine from the condensed steam.

Since the vapors leaving the relief connection are mixtures of steam, turpentine, and inert gas it is essential that the surface within the condenser be disposed so as to get strictly countercurrent flow of the vapors with respect to the cooling water in order to cool the exit gases to a minimum and recover the maximum amount

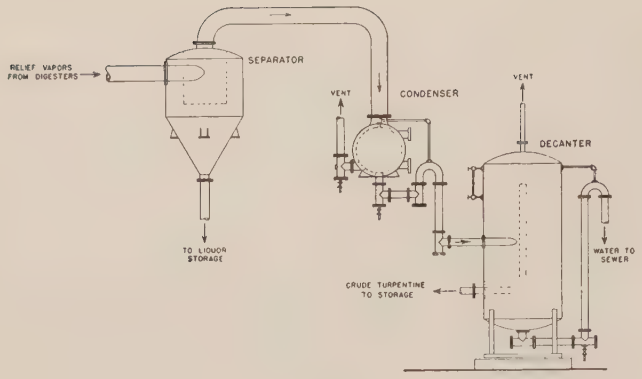


Fig. 4

of turpentine. Temperature regulation of the water supply is desirable to minimize water use and provide an exit water temperature corresponding to the desired pulp wash water temperature.

SULPHUR DIOXIDE RECOVERY

In sulphite cooking, sulphur dioxide is released upon blowdown at rates on the order of 100 to 125 pounds per ton of pulp. The release of sulphur dioxide is a nuisance to the surrounding neighborhood. Furthermore, the sulphur dioxide has a reclaimable value which warrants a considerable investment for its recovery.

Blowdown sulphur recovery systems vary with the local plant conditions. However, such systems must dispose of about 19 to 20 pounds of steam for each pound of sulphur dioxide released. It is not customary that use can be found for water heated by blowdown steam in the sulphite mill. Hence, in many cases, no credit may be taken for saving the heat in this released steam.

A blowdown sulphur recovery system consists generally of a primary condenser and water supply capable of condensing the steam and absorbing the sulphur dioxide during the short blow period, a storage system for the heated condensing water containing the absorbed sulphur dioxide as a very weak solution, and a system for concentrating the sulphur dioxide to a usable concentration. This latter would operate continuously during the blow periods as well as between blow periods.

Figure 5 is a flowsheet of a sulphur dioxide recovery system as proposed for a 320-ton per day sulphite pulp mill in which there was no use for the heat released at blowdown.

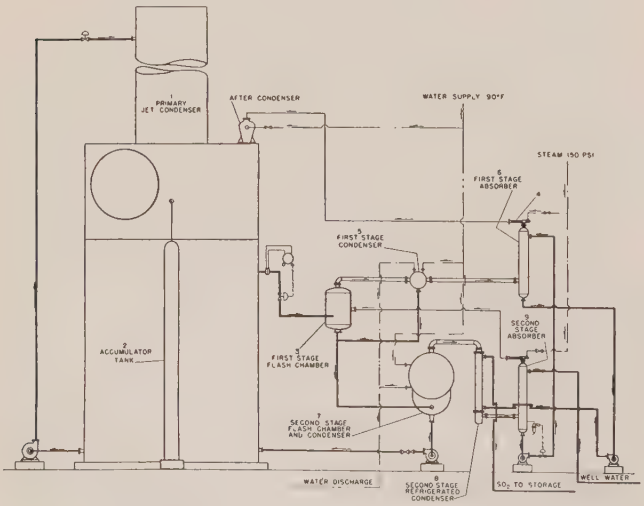


Fig. 5. Digester blowdown SO_2 recovery system

Blow steam is condensed and sulphur dioxide is absorbed in a primary jet condenser (1) with the heated condensing water delivered into accumulator tank (2). A flow controller regulates the flow into first stage flash chamber (3) held under vacuum corresponding to about 380 mm. mercury by steam ejector (4). Steam and sulphur dioxide are flashed off in the flash chamber and released to the first stage condenser (5) within which almost all of the flash steam is condensed. The sulphur dioxide with the remaining water vapor passes through absorber (6) within which the sulphur dioxide is absorbed by chilled water.

The condensation from condenser (5) together with the hot water from flash chamber (3) passes to a second stage combined flash chamber and surface condenser (7) held under a vacuum corresponding to about 78 mm. mercury wherein steam and most of the remaining sulphur dioxide are flashed off thereby cooling the remaining water in the circuit to about 115°. This water is returned to the bottom of the storage tank ready to serve the primary condenser at the next blow.

The flash steam not condensed and the sulphur dioxide released pass through a tubular subcooler (8) into the second-stage absorber (9) both served by well water at a temperature of about 50°F.

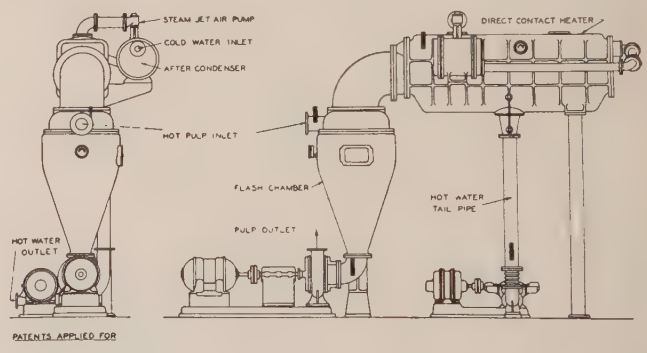


Fig. 6

The well water circuit is through the second-stage absorber (9) to the first-stage absorber (6) within which the sulphur dioxide is dissolved, thence through second-stage subcooler (8) and out to storage. The indicated recovery of sulphur dioxide in this system would be about 80% with the final concentration of the solution 4%, as based upon the use of 85° condensing water.

This recovery corresponds to 80 to 100 pounds of sulphur dioxide per ton of pulp. Utility costs of the operation would be: 80 kw. hr. per ton of SO_2 recovered and 35 pounds of steam per ton of SO_2 recovered.

In many cases it would be possible to take advantage of an appreciable portion of the heat in the released steam from the blow of a digester for preheating the charge liquor for subsequent digester operation. This would greatly increase the value of a recovery system.

HEAT RECOVERY IN DEINKING PLANTS

In the deinking plant, in which caustic liquors are heated for the dissolving of ink from book stock, it is possible to preheat the liquor by means of heat released from the cooked pulp. For such service it, of course,

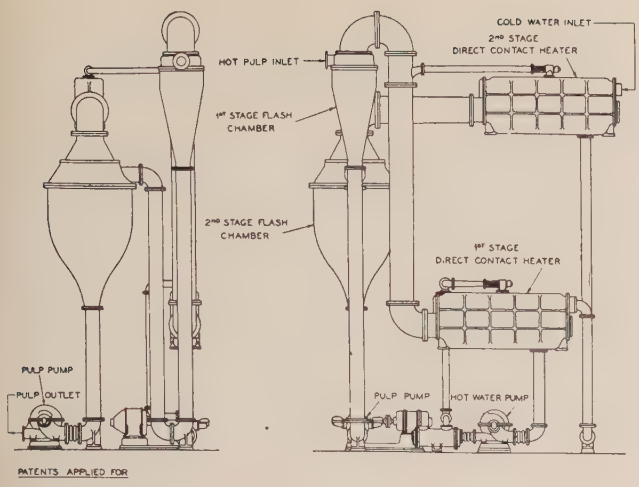


Fig. 7

would be impossible to use tubular heat exchangers as they would plug so rapidly as to be useless.

A method of overcoming this difficulty is to introduce the hot pulp into a flash chamber held under vacuum and flash-evaporate a portion of the water content into steam which enters a condenser-heater where it heats the process water.

Figure 6 shows the simplest form of such a heat exchanger. The pulp enters the conical flash chamber and is practically instantaneously cooled to a temperature corresponding to the vacuum produced by the steam-jet air pump. The pulp pump removes the pulp from the flash chamber. The steam flashed enters the condenser and heats the process water which, with the condensed steam, is removed by the hot-water pump. With a single-stage system with hot pulp at 212° and raw water at 70° a heat recovery efficiency of about 45% may be expected.

Figure 7 shows the arrangement of a two-stage flash heating system in which the pulp is flashed successively in a low-vacuum flash chamber and then in a high-vacuum flash chamber with the steam flashed from the two chambers being condensed in separate water condensers. The flow of the process water would be first through the condenser for the high-vacuum flash chamber and then through the condenser for the low-vacuum flash chamber, thus establishing water flow through the apparatus counter to that of the pulp. Loop seals in both the pulp and the water circuits permit the maintenance of the difference in pressure between the two stages. Removal pumps for both the pulp and the heated water deliver these materials to the next step in the process. With an entering pulp temperature of 212° and a raw-water temperature of 70°, a heat-recovery efficiency of somewhat better than 60% may be expected.

HEAT RECOVERY FROM MACHINE ROOMS

In the machine rooms of paper mills, the heat losses represented by the evaporation of water from the paper and by convection from drier rolls are appreciable.

It is necessary to furnish a continuous supply of air in machine rooms to bring about the evaporation of the water at a reasonably low temperature. The air from outdoors is heated in two ways after entering the room; by the steam given off by the drying paper and by contact with the exposed portions of the drier cylinder. The air at the top of the room may be at temperatures of 150 or 160°F. When this hot air discharges from the room it usually is not saturated although it contains a large amount of moisture. This is due to the superheating effect of the hot, dry surfaces of the cylinder exposed to the air in the room.

The fact that this air is at an exit temperature as high as 150°F. makes it possible to recover profitably some of the heat ordinarily carried away.

Heat may be recovered from the moisture-carrying heated air by two methods:

1. By heating air for introduction into the paper machine to assist in the drying, or for building heating. This method of heat recovery calls for a surface-type heater or economizer as it is usually called. While the installation of such equipment is expensive, it pays for itself in a great many cases.

2. The heating of water for mill use. This type of installation is relatively inexpensive and if there is use for water at moderately warm temperature, this installation will pay for itself in a few months.

The type of equipment customarily used is a spray type or filled direct-contact tower through which the heated air passes coming in contact with the water to be heated falling through the tower.

The spray type of tower usually is not as costly as the filled tower. However, the latter, because of greater surface exposure and time of contact, is more efficient.

The following results of test indicate what may be accomplished with a heating tower for this service:

Air Leaving Machine Room:	
Quantity, cu. ft. per min.	61,800
Dry bulb temperature, °F.	151
Wet bulb temperature, °F.	118
Water Heated:	
Quantity, g.p.m.	348
Inlet temperature, °F.	66
Outlet temperature, °F.	110
Equivalent steam saving from and at 212°F., pounds per hour	7890

In general, it may be stated that water can be heated in a reasonably sized heating tower to less than 10° below the wet bulb temperature of the heated air.

THE STEAM ACCUMULATOR

The application of the steam accumulator to pulp mills is old practice. The sudden large demands for steam when digesters are being heated are quite upsetting to the steam and power generation of the plant.

Some years ago when steam for digester heating was taken directly from the boilers at a moderate pressure somewhat in excess of the pressure necessary for digester heating, the use of the steam accumulator was more

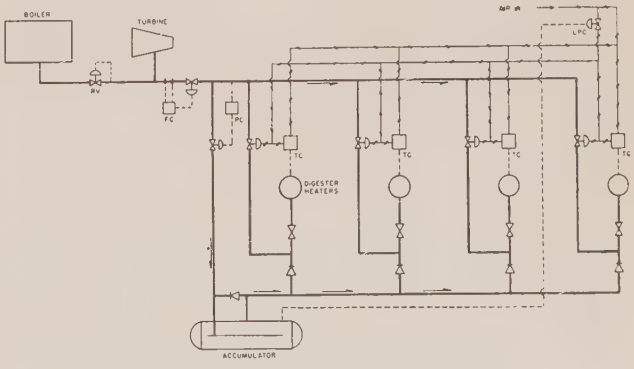


Fig. 8. Digester control system

common than it is at present. The practice was to operate the boilers at a practically constant rate corresponding to the average total demand for power and digester heating purposes. By means of an overflow valve set to open when the steam demand should decrease below the average, steam from the high-pressure main was introduced into the accumulator to be stored as hot water ready for release whenever the demand for steam should be in excess of the average. At such times, steam would be delivered to the main by the accumulator thus assisting the boilers in carrying the load. In this way the accumulator would serve as a thermal fly wheel for the plant.

With present practices, however, according to which steam is generated at pressures of 400 to 600 p.s.i., with steam extracted from the turbines at 150 to 175 p.s.i. for digester heating, it is uneconomical to operate an accumulator by charging it with high-pressure boiler steam which otherwise could be used for the generation of power by expansion to the extraction pressure, even in cases in which extraction steam is used for digester heating. The sudden demands whenever digesters go "on steam" would in many cases be quite upsetting to turbine operation unless boiler steam should be bypassed around the turbine to the digester steam main with the consequent loss of power-producing capacity of such steam.

Attention should be called to the possibility of avoiding such upsetting conditions by making use of a steam accumulator charged with steam from the extraction line and to be discharged to a low-pressure header for supplying the digesters during the early stages of heating.

To illustrate what may be accomplished in this manner, there may be assumed an installation of four digesters each of about 3400 cubic feet capacity and each served by an external circulating system with a tubular heater. It is assumed that the heating period for each digester is one hour, with a total of twenty cooks per day. Thus there would be a digester going on stream every hour and 12 minutes. In order to heat a digester of this capacity from 140 to 350° there would be required about 40,000 pounds of steam to be used during the heating period of one hour to which should be added the steam, assumed to be 10,000 pounds per hour, required for holding the other digesters at temperature.

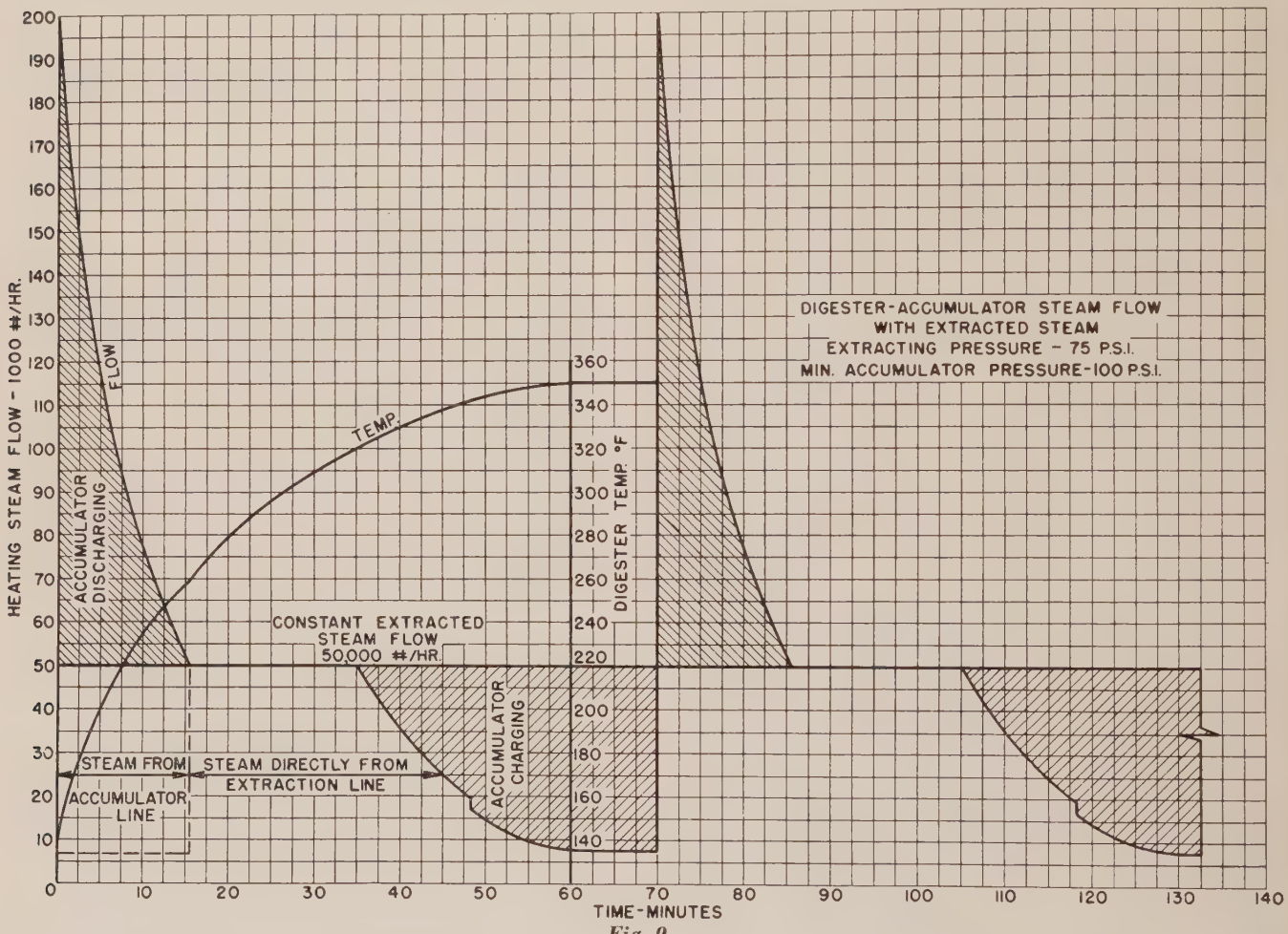


Fig. 9

Assuming steam available at the heaters at 155 p.s.i.g., the condensing capacity of the heaters when liquor is cold would be as much as four times the average rate of steam required during the cooking period. This peak demand would be of short duration and would be quite upsetting to the steam system. Inasmuch, however, as the earlier portions of the heating range can be met satisfactorily with steam at a pressure less than that of the extracted steam, it would appear that a steam accumulator might be of service.

Figure 8 shows the system with an accumulator to be charged with steam at the extraction pressure, but to

discharge at 100 p.s.i. The digester heaters are supplied by two steam mains.

One main is from the accumulator with a check valve in the branch to each digester heater. The check valve in any branch would open whenever the presssure in the heater supply line might be less than the accumulator pressure and would be closed if the branch line pressure were greater than the accumulator pressure.

The other, or high-pressure main, would serve the digester heaters directly from the extraction line. The branch to each heater would be supplied with an automatic temperature controlled valve. The high-pressure line would be fitted with a flow controller set to pass steam to the heaters at the average rate of steam flow required throughout the day.

The branch to the accumulator would be supplied with a valve set to open whenever the pressure in the extraction or high-pressure line should exceed a predetermined value and normally to be closed whenever the pressure in the high-pressure line should be lower than the set value.

In operation the temperature controller serving the valve in any of the branches from the high-pressure line to the heaters would be set to be closed until the temperature of the liquor in the digester being heated should have reached 260°. Up to this point steam would have been fed into the heater from the accumulator. Upon the opening of the automatic valve in the high-pressure branch the check valve from the accumulator branch would be closed and thenceforth heating would be by means of the extracted or high-pressure steam. Near the end of the cook the digester temperature would be such that with the decreased temperature difference between it and the steam, the steam could not be condensed at the average rate as permitted by the flow controller valve. At this point the pressure in the extraction line would tend to rise opening the overflow valve to the accumulator. Henceforth, till the end of the cook and during the period before the next cook starts, steam would flow into the accumulator and recharge it for the next cycle.

Provision is made to insure steam supply to the digester heaters at all times even if the pressure in the accumulator should be too low to heat the digester to the set points of the automatic control valves.

To provide for such contingencies there is included a pressure-controlled valve actuated by the pressure in the accumulator and set to open the air line to the automatic high-pressure steam supply valves to the digester heaters to open them whenever the pressure in the accumulator should be too low to be operative.

Figure 9 shows, diagrammatically, the variation of the steam supply to the digesters. Also, it shows how the supply of steam from the extraction system may be kept practically constant while the steam requirements in excess of this average rate during the early period of the cook may be supplied from the accumulator. The steam so taken from the accumulator would be replenished during the blowdown and charging period.

Received Nov. 1, 1949. Presented at the Fourth Engineering Conference sponsored by the Technical Association of the Pulp & Paper Industry, Boston, Mass., Oct. 31, Nov. 1–3, 1949.

The Rheology of Paper Coatings

WILLIAM R. WILLETS

The importance of the rheological characteristics of coating colors, especially in view of the modern high-speed printing techniques of application, is discussed. The complexity of coating color systems is described. While no presently available viscometer truly simulates the high shearing effects experienced in practice, tests should be made with a multipoint viscometer so as to give some indication of thixotropic or dilatant characteristics as well as of apparent viscosity. Certain factors affecting the rheological properties of coating colors were investigated using such a technique. It was found that a relationship between the rheological properties of the slip and the final coating color did not necessarily exist. A very slight difference in the total solids content of coating colors resulted not only in marked changes in apparent viscosity but also in thixotropic characteristics, but the changes resulting from dilution varied with different colors. Coating colors behaved differently on storage, some becoming less viscous and some developing more body, the effect evidently depending on such factors as composition, dispersants, pH, and total solids. The use of dispersing agents was very critical and it was apparent that an excess would result in increased viscosity as would the use of too little. The optimum amount to be used varied with different compositions. Dispersants were found to affect the storage stability as well as the rheological characteristics of the colors as made. While no general rule applicable to all types of coating colors could be derived from this work, the principles and techniques involved could be applied to a specific color to be used in a definite application process.

Until the advent of high-speed coating processes both on and off the paper machine, most coating colors were of such low total-solids contents that they were very fluid and in fact generally were assumed to be almost Newtonian in behavior. However, most of the colors in common use today are plastic in nature, that is a definite force is required to initiate flow. Many such colors when at rest develop a gellike structure and thus body or thicken. These structures can be rendered fluid by the application of shearing forces but the permanence of the fluid state is dependent on the maintenance of shear and the gel structure reforms when the shearing force is removed—i.e., they are thixotropic.

It is easy therefore to see why a combination of the high shearing rates embodied in modern coating processes (especially those employing printing principles) and the extreme complexity of the systems in the high total solids coating colors employed make rheological characteristics of such prime importance.

William R. Willets, Member TAPPI, Chairman Pigments Subcommittee, TAPPI Coating Committee; Technical Service Laboratories, Titanium Pigment Corp. a subsidiary of National Lead Co., New York, N. Y.

A typical example would be a "letter-press printing" application at speeds of over 1000 f.p.m. in which the viscous coating film is being built up by means of a train of oscillating rolls to a definite thickness and then printed on the sheet. A coating for such a process should probably be thixotropic in nature so that it would be leveled in the nips to a smooth uniform film which would "set" as such a smooth film immediately after being printed on the paper. A different example would be furnished by an "offset-intaglio printer" in which the coating is carried in the depressions of an engraved roll, and removed from them by a rubber blanket roll which prints it on the sheet. Here it would seem that more flow (or at least less tendency to set up quickly) would be desirable; in any event it would not seem that a coating which would prove satisfactory in the first instance would work equally well here.

Lyons (*1*) has discussed the importance of rheological properties in color application. He described the behavior of the color in the nip of a simple roll coater, and showed in one example that a dilatant color gave a more definite pattern and a rougher coating than did a thixotropic color. In another test a very thixotropic color at 65% total solids gave a rougher coating than the same color at 60% total solids which was therefore less viscous and thixotropic.

The importance of rheological characteristics is not necessarily confined to high-speed equipment using colors of high-total solids. An example of this is furnished by the case of four colors made to be applied at fairly low-total solids on a typical brush coater. Two of them applied very well, spreading evenly and causing no difficulty, while the other two spread very poorly. Tests by different individuals using different equipment only created more confusion because in one instance the satisfactory colors were reported as thixotropic and the unsatisfactory as Newtonian, in another instance the reverse was reported, while in a third instance all colors were reported as Newtonian and as having approximately the same viscosity. Here, even though the particular rheological characteristic causing the difficulty could not be determined, probably such characteristics were the factors governing the efficacy of application, although there may also have been differences in the redistribution rate of the adhesive vehicle which may have entered the picture.

It has often been said that the only real way to determine whether a given paper will print with a given ink on a given press is to print it with the ink on the press in question. Similarly it could also be said that the only way to determine how well a given color will apply to a given raw stock on a given coating machine is to apply it. Nevertheless, rheological measurements, even granting that present apparatus and technique do not simulate conditions in practice, can at least give an indication of the behavior of coatings when applied.

Even the simplest types of rheological measurements are better than none. In some plants such a measurement consists simply of observing how a color drips from the end of a spatula or paddle, many plants have used viscosity cups of one type or another, while more progressive plants have installed viscometers capable of giving multipoint consistency data, and thus some idea of thixotropy or dilatancy as well as of "apparent viscosity."

The fact that "single point" measurements, such as would be obtained with a viscosity cup, are incapable of giving any real indication as to how non-Newtonian fluids would behave has been amply discussed by the late Henry Green (*2*), as well as by others too numerous to mention. He has pointed out that "single-point" measurements giving values for "apparent viscosity" are not comparable, and has answered the arguments that multipoint techniques are too difficult for practical use.

With some of the above thoughts in mind but without consideration of the theoretical aspects (which have been amply discussed by the late Mr. Green and others) a study was made of some of the factors which affect the rheological characteristics of paper coating colors. The results being presented represent information gleaned from a wide variety of experiments, many of them performed to develop information quite aside from that pertaining to rheological characteristics which, however, were determined as a matter of routine. Since interest has been shown by a number of individuals in the coating and allied industries in such results, even granting that they were not obtained on an over-all systematic basis, it seems worth while to present the data available with the hope of eventually performing additional work more systematically.

TECHNIQUE

The technique used in obtaining the results given in the following sections was very simple. Various slips

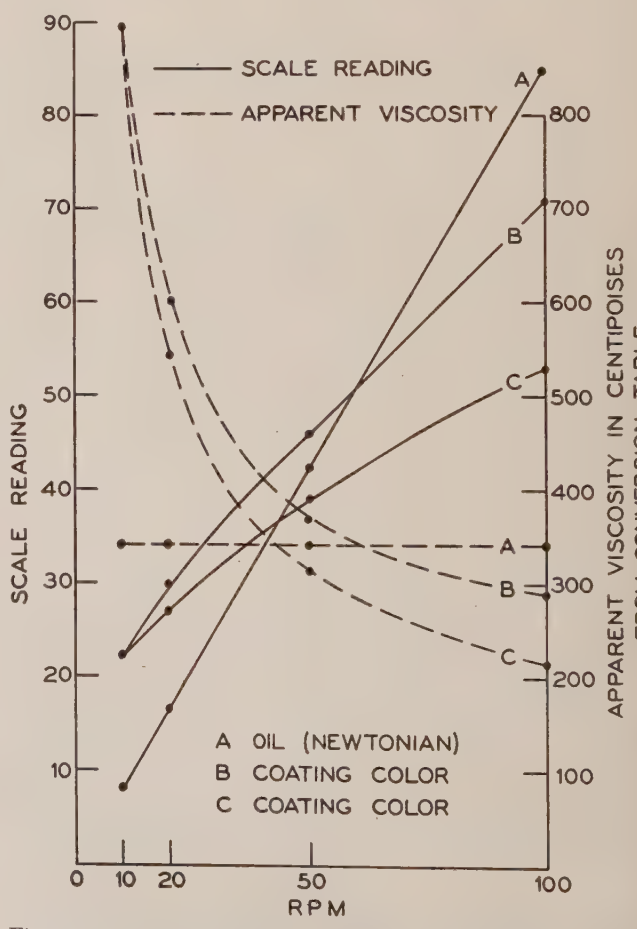


Fig. 1. Relation of scale readings and apparent viscosity (Brookfield Synchro-Lectric Viscometer)

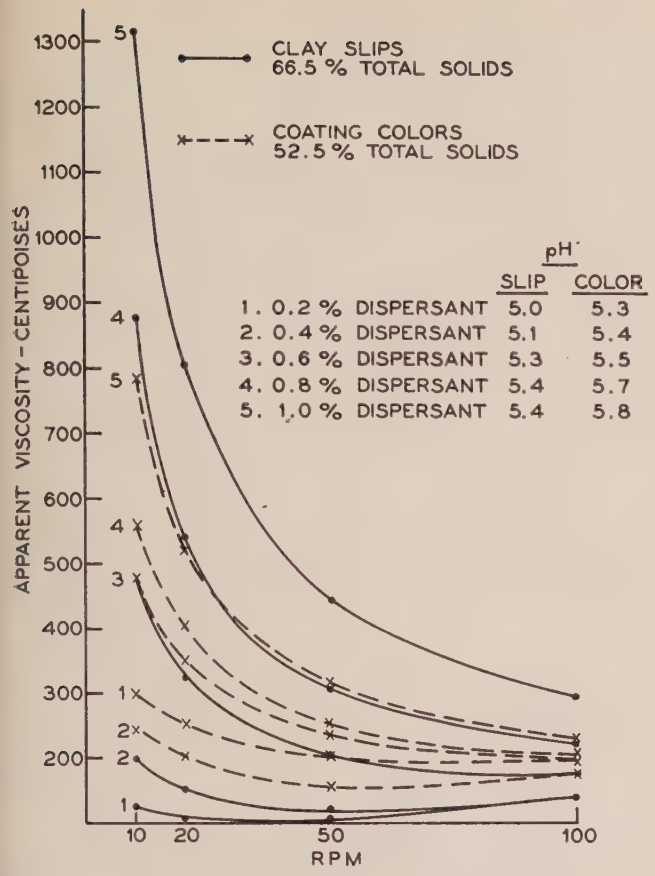


Fig. 2. Relation between clay slip and coating color viscosities

and coating colors were prepared and the viscosity measured on the Brookfield Synchrolectric Viscometer having four speeds—10, 20, 50, and 100 r.p.m. While it is fully realized that these speed ranges do not (at least in many cases) correspond to the shearing forces and rates obtained in actual coating practice they do furnish multipoint readings and at least indicate thixotropy or dilatancy.

However the term "thixotropy" is here used in something less than its true scientific sense. This term is applied to a type of structure which is destroyed by agitation (i.e., becomes less viscous) and which rebuilds itself upon rest (i.e., bodies or becomes more viscous). There is a definite time element involved in this reversible gel-sol-gel transition. If a thixotropic mixture is tested on some types of rotational viscometers with increasing and decreasing shearing rates, the up curve and the down curve do not coincide, and a hysteresis loop is formed. This hysteresis loop is usually considered the criterion of thixotropy (*3*). Unfortunately in the work reported herein it was not possible to consider this "time element" and the term thixotropy is used to describe mixes which break down and become less viscous on agitation, while the term dilatant is used to describe mixes which become more viscous on agitation.

In all cases scale readings have been converted to "apparent viscosity" expressed in centipoises by using a conversion table supplied with the instrument. Such apparent viscosities have been plotted against the rate of shear as expressed in revolutions per minute. In some cases apparent viscosities at a given rate of shear are plotted, but in such cases an arbitrary figure, "thixotropic index" is also included, which is merely the ratio between the apparent viscosity at the lowest rate of shear (i.e., 10 r.p.m.) and the apparent viscosity at the highest rate of shear (100 r.p.m.)

Examples of converting scale readings at the different rates of shear to apparent viscosity are shown in Fig. 1 for a Newtonian liquid and two thixotropic coating colors. When scale readings were converted to apparent viscosity the Newtonian liquid A gave a straight-line horizontal curve. While both coating colors had the same apparent viscosity at the lowest rate of shear, C became less viscous than B as the rate of shear increased, i.e., tended to be more thixotropic, C having a thixotropic index of 4.15 as compared to 3.1 for B.

THE RELATIONSHIP BETWEEN SLIP VISCOSITY AND COATING COLOR VISCOSITY

It might be assumed that the viscosity of the pigment slip (i.e., of the pigment-water slurry) would have a direct relationship to the viscosity of the coating color (i.e., the final coating mix made from the pigment-water slurry and adhesive) but this is not necessarily true. This was shown by preparing water slurries of clay or titanium dioxide with different amounts of a dispersant (sodium hexametaphosphate), at 66.5% total solids and then adding sufficient 25% starch solution to give a starch-pigment ratio of 20% and a total solids of 52.5%.

In the case of clay when 0.2 and 0.4% dispersant were used the viscosity of the 66.5% slips was lower than that of the 52.5% coating colors, when 0.6% dispersant was used the viscosities were more nearly equal, and

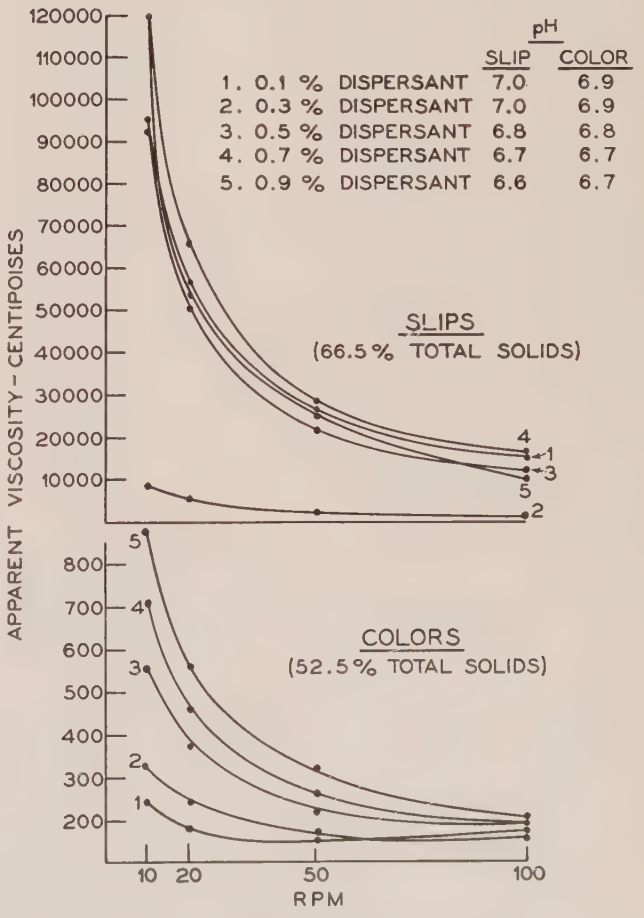


Fig. 3. Relation between titanium dioxide slip and coating color viscosities

when 0.8 and 1% dispersant were used, the viscosity of the coating colors was lower than that of the slips. At 0.2 and 0.4% dispersant, both the slips and the coating colors were thixotropic at the lower rates of shear, as shown by the lowering of the apparent viscosity at 10, 20, and 50 r.p.m., both then showed dilatant tendencies as indicated by the higher apparent viscosity at 100 r.p.m. At higher dispersant additions, all the slips and coating colors had thixotropic characteristics throughout the shear range which became more pronounced as the dispersant was increased (Fig. 2).

The titanium dioxide slips all were very viscous and thixotropic, but the one with 0.3% dispersant was much less so than when either more or less dispersant was used. However, the viscosity and thixotropy became very much less after the addition of the starch vehicle, falling within the range of the clay-coating colors, again showing the lack of correlation between the viscosity of a slip and the coating color made from it (Fig. 3).

Even though there is no apparent correlation between slip viscosity and the viscosity of the final coating color, in some instances with a given pigment (for example, a specific species of clay) slip viscosities may indicate the rheological properties of the final color. In any event, a viscosity evaluation of a heavy slip is of importance in estimating its rate of flow through fine screens in operations which require screening of such slips (*4*).

Asdell (*5*) has described in considerable detail various factors governing the rheological characteristics of clay slips but did not discuss the colors made from them.

Since there apparently is no correlation between the viscosity of the slips and the coating colors made from

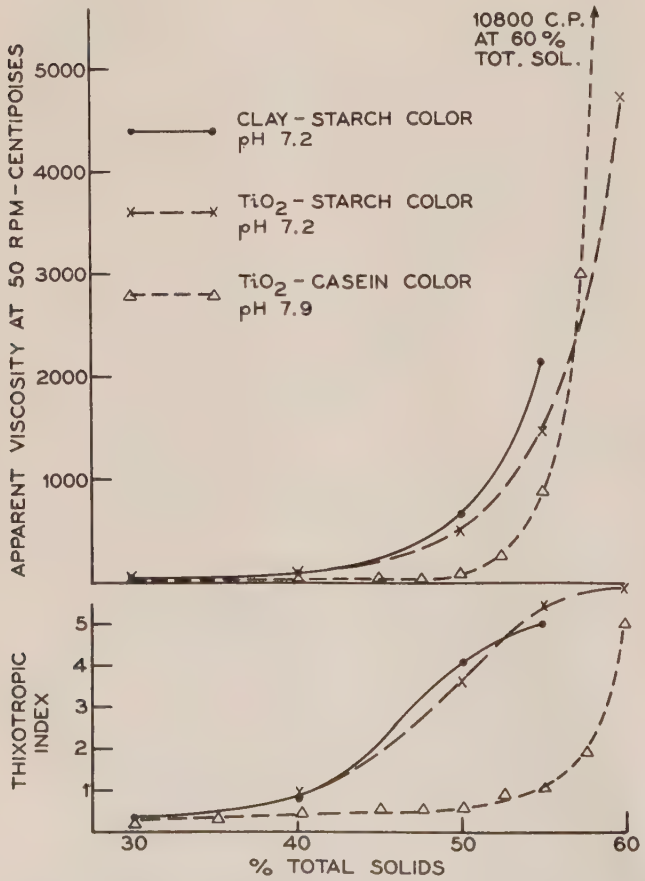


Fig. 4. Effect of total solids on viscosity (single pigment colors)

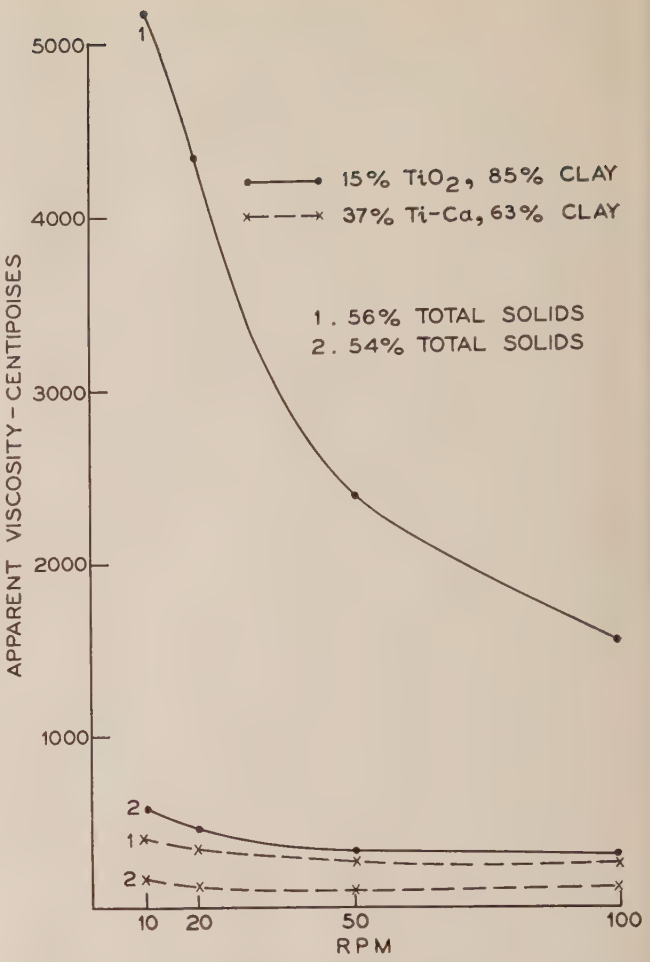


Fig. 5. Effect of total solids on viscosity (pigment combination colors—casein adhesive)

them the following sections will deal only with the viscosity of the finished coating colors so as to avoid the complications of having to record the data for the slips (although this was always determined).

EFFECT OF TOTAL SOLIDS

It is well known that the total solids content of either a slip (*4*) or a coating color has a very marked effect on flow characteristics, but the magnitude of the difference caused by a slight variation may not be fully appreciated.

In the following work, a clay color and a titanium dioxide color were made with 20% starch adhesive ratio at a pH of 7.2. The clay color had as dispersants 0.2% sodium hexamethaphosphate and 0.15% caustic soda (based on the clay) while the titanium dioxide color had 0.1% sodium hexametaphosphate. In addition tests were made on a titanium dioxide color with 12.5% casein adhesive at a pH of 7.9. After preparation of the heavy total solids colors (55% in the case of clay and 60% in the case of titanium dioxide) the mixes were diluted and viscosity measurements taken at each point.

It is obvious from the curves of Fig. 4 that the apparent viscosity increased rapidly above 40% total solids in the case of the starch colors and 50% solids in the case of the casein color.

At high-total solids content, the starch-coating colors were very thixotropic, this thixotropic tendency becoming less below 40% total solids at which point the

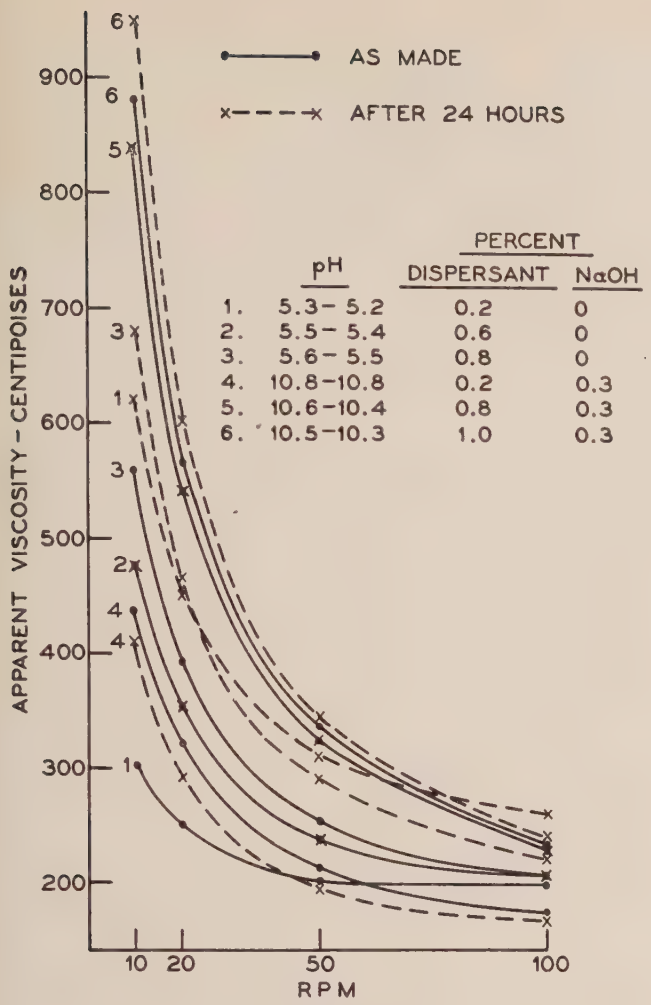


Fig. 6. Effect of storage on viscosity (starch-clay colors—52.5% total solids)

curves tended to approach an almost Newtonian liquid within the limits of the shearing rates used and then became dilatant. This phenomenon occurred at much higher total solids, about 55%, in the case of the casein color.

While the foregoing discussion has dealt with coating colors made with a single pigment, similar effects with pigment combinations are just as pronounced. This is shown in the case of two coatings, one made with a mixture of 85% clay and 15% titanium dioxide and the other with a mixture of 63% clay and 37% rutile titanium calcium pigment. The adhesive ratio in both cases was about 11.5% borax-cut casein. About 0.35% of soda ash and slightly over 0.2% of sodium tetraphosphate based on the pigment were used as dispersants, and in the case of the rutile titanium-calcium color, about 1.25% of gum arabic.

As can be readily seen from the curves of Fig. 5, the difference in viscosity between the titanium dioxide-clay color at 56% total solids and at 54% total solids was very significant, as was the fact that the higher total solids color exhibited far more thixotropic tendencies. In the case of the rutile-titanium calcium pigment-clay color, the difference in viscosity brought about by a difference of 2% in the total solids, while less pronounced than for the titanium dioxide-clay color, was still very appreciable.

It is obvious from the few examples given above that relatively small differences in total solids can make very appreciable differences in the rheological characteristics of the color, not only as far as apparent viscosity is concerned but also in thixotropic or dilatant tendencies. The "thinning down" of a too-thick color may well involve not only lowering its apparent viscosity but may also change its whole rheological structure.

EFFECT OF STORAGE

While in many cases coating colors are used soon after preparation, they are frequently stored overnight or longer before being applied on the coating machine. The effect of storage on rheological characteristics may vary considerably, some colors may thin down, some body, and some remain virtually unchanged.

That this may be the case is shown in Fig. 6 for a series of clay colors, all at 52.5% total solids and all with 20% starch-pigment ratio, with the only difference the amount of caustic soda and dispersant (sodium hexametaphosphate) used. The viscosity and pH of each color were determined after preparation and after slow agitation for approximately 24 hours.

It will be noted that when no caustic was used, the color became more viscous and thixotropic on storage with the use of 0.2 and 0.8% dispersant, but that at 0.6% dispersant addition the viscosity and thixotropy was the same both immediately after preparation and after 24 hours storage, the curves coinciding. The pH of these colors was all on the acid side with a tendency for the pH to decrease slightly on storage.

When 0.3% caustic was used resulting in a distinctly

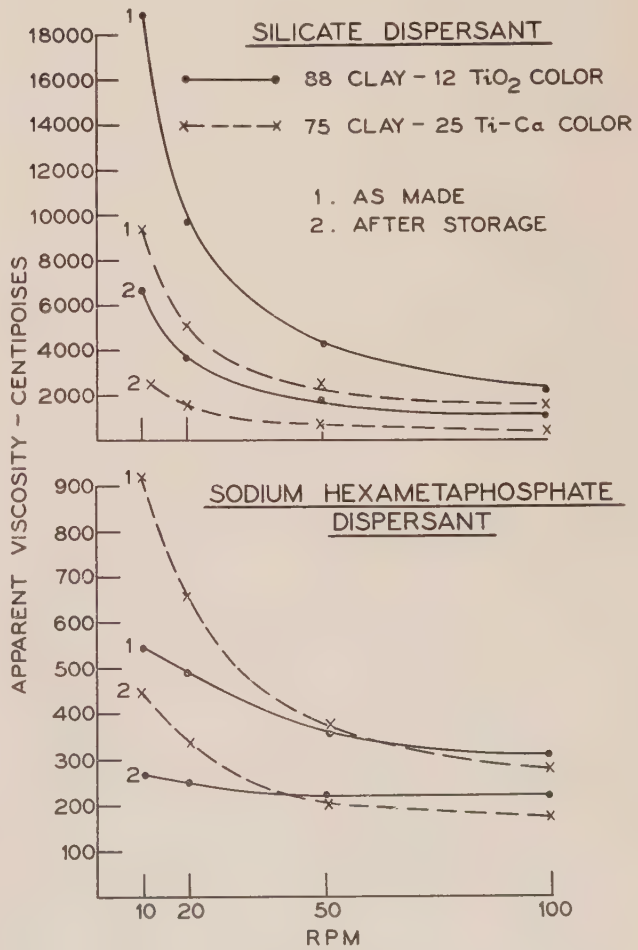


Fig. 7. Effect of storage on viscosity (casein colors—45% total solids)

alkaline pH the color made with 0.2% dispersant showed a slight drop in viscosity on storage, while those made with 0.8 or 1% dispersant had practically the same viscosity as made and after storage.

The foregoing work indicates that the rheological stability of starch-clay colors on storage is somewhat dependent, at least, on the amount of dispersant used, and that colors on the alkaline side may tend to be somewhat more stable than colors on the acid side.

Experience with casein colors has indicated that they tend to become less viscous on storage, although this generalization probably would not apply in all cases. Casein colors made with a mixture of clay and titanium dioxide, or a mixture of clay and rutile-titanium calcium pigment, with a casein ratio of about 15% at 45% solids using sodium silicate as the dispersant showed a marked decrease in viscosity and thixotropy upon storage. While this was true with the very viscous colors in which sodium silicate was used as the dispersant, in the much more fluid colors in which sodium hexametaphosphate was used as the dispersant, the apparent viscosity of the colors at the low shearing rates increased after storage, but at the higher shearing rates decreased slightly, so in this case the thixotropy on storage actually increased (Fig. 7).

Evidently storage in agitated tanks, or in containers without agitation, can produce radical changes in the

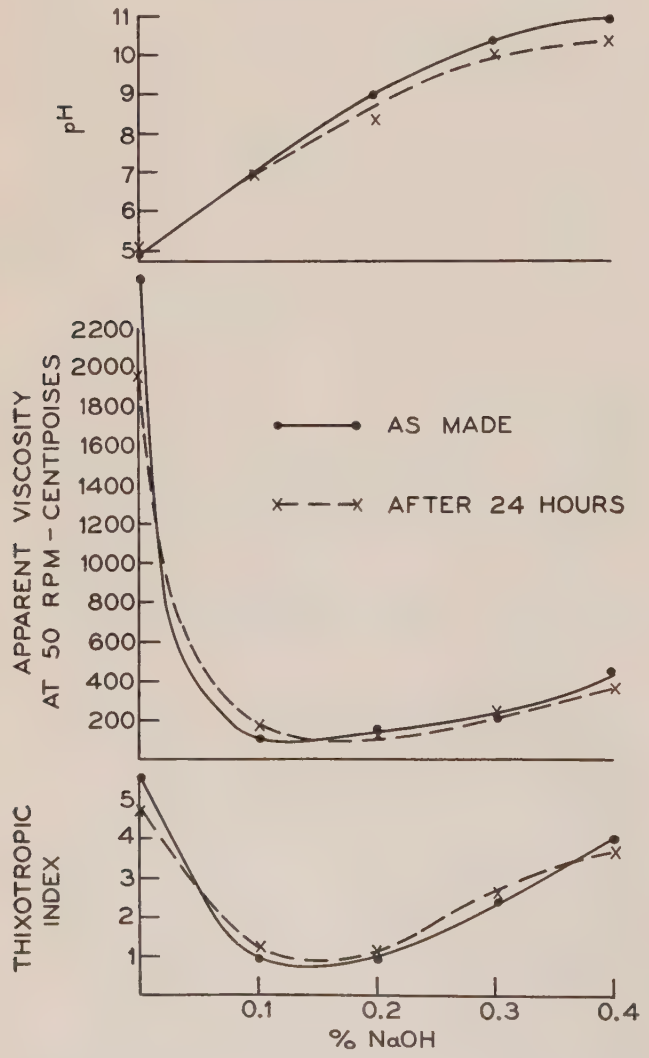


Fig. 8. Effect of alkali on viscosity of starch-clay colors (52.5% total solids)

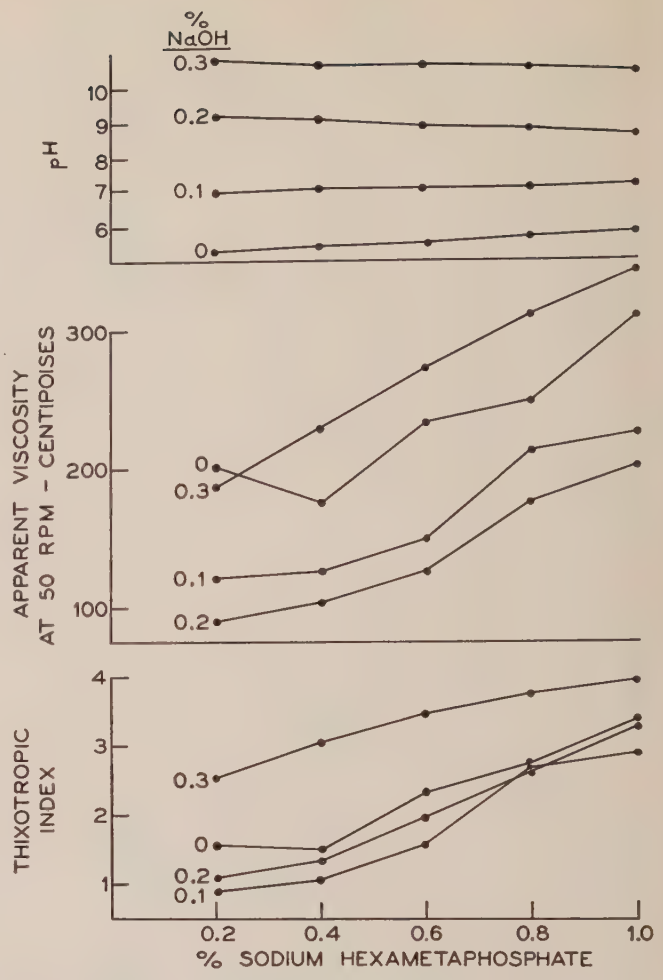


Fig. 9. Effect of dispersant on viscosity of starch-clay colors (52.5% total solids)

rheological properties of coating colors. Such changes are not predictable and it is not an infrequent experience to have a coating "go bad" in the tank, either bodying to such an extent that it must be thinned down with water (and the critical effect of total solids not only on apparent viscosity, but also on thixotropy or dilatancy as well, has already been discussed), or else the color may thin down and become so watery that it is difficult to apply. A third possibility, of course, is that the color may remain rheologically stable on storage. In general agitation may be said to make colors that have a tendency to thin down on storage thin down even more, but with coatings that have a tendency to body, agitation reduces the tendency.

EFFECT OF DISPERSANTS

The critical effect of dispersants on the rheological characteristics of coating colors both as made and after storage has already been indicated in foregoing sections. As is the case with clay slips (*4*, *5*), there is an optimum amount of dispersant to give the minimum viscosity and quantities above or below this amount result in increased viscosity.

The effect of pH, as controlled by the use of varying amounts of caustic soda, in a clay color of 52.5% total solids with 20% starch adhesive, using 0.15% sodium hexametaphosphate (based on the clay) as a dispersant, was found to be very pronounced, as shown in Fig. 8. The viscosity and thixotropy were at a minimum at a pH between 7 and 9 resulting from the use of 0.1 and

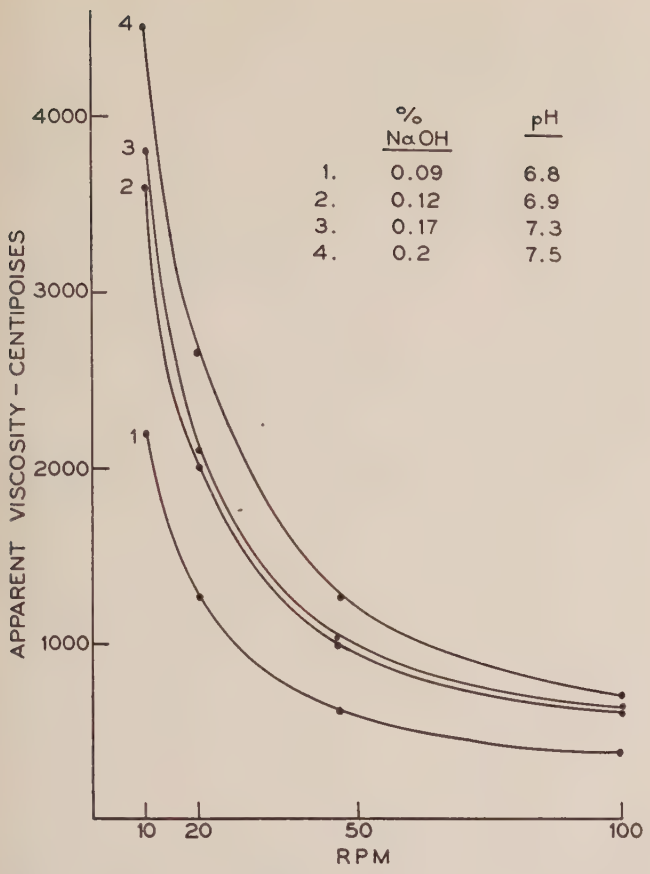


Fig. 10. Effect of alkali on viscosity of rutile titanium calcium-clay color (starch adhesive—50% total solids)

0.2% caustic soda (based on the clay) and increased as the pH increased. The viscosity and thixotropy were very much higher when no caustic soda was used and the color therefore had an acid pH. While the pH tended to decrease somewhat on storage, the apparent viscosity and thixotropy did not manifest very much change.

The influence of pH on the viscosity of clay slips has been indicated in previous work (*4*) in which the effect of adding sodium carbonate to clay slips dispersed with either tetrasodium pyrophosphate or sodium hexametaphosphate was determined. It was found that in the former minimum viscosity was obtained with 0.08% sodium carbonate based on the clay, and in the latter case with 0.1%.

The data of Fig. 8 have been affirmed by a series of tests on similar coating colors made with different amounts of sodium hexametaphosphate and caustic soda. When no caustic soda was used, resulting in an acid pH, minimum viscosity and thixotropy were found with 0.4% sodium hexametaphosphate. Amounts over 0.4% gave considerably increased viscosity. The use of 0.1 and 0.2% caustic soda gave lower viscosity and thixotropy but these increased with increasing amounts of sodium hexametaphosphate over 0.2%. The use of 0.3% caustic soda gave the highest viscosity and thixotropy, which also increased with increasing amounts of sodium hexametaphosphate. Such data confirm the opinion that there is an optimum amount of dispersant to be used at an optimum pH to give minimum viscosity and thixotropy (Fig. 9).

The fact that rather small differences in pH may produce marked differences in the rheological properties of a coating color was also shown by a series of tests made on a color containing a mixture of clay and rutile-titanium calcium pigment, with 20% starch as the adhesive. A large amount (1.2%) of sodium hexametaphosphate was used as the dispersant and the pH increased by increments of caustic soda. As the pH was increased from 6.8 to 7.5 the viscosity and thixotropy of the color increased, as shown in Fig. 10.

It has been stated with substantiating evidence (*4*) that in contrast to clay-starch colors, the use of dispersants in clay-casein colors produces no increase in fluidity and that if used in excessive amounts may cause increases in viscosity. The explanation is given that alkaline casein is in itself an effective dispersing agent and the system becomes so constituted that additional treatment results in flocculation. However, the above statements are not completely borne out by other investigators (*6, 7*).

It is evident from all available information that dispersants may be among the most critical factors affecting the rheological characteristics of a coating color, and it is also evident that no general rule can be laid down as to the optimum to be used, or at what pH, to produce minimum viscosity and thixotropy. Certainly the necessity of selecting the proper dispersant and the amount to be used to produce the desired rheological properties assumes prime importance and should be a matter for investigation with any coating color. It is not uncommon for mills using coating colors of widely different compositions to use the same type and amount of dispersant for each and every color, although the different colors might prove more satisfactory if the optimum type and amount of dispersant were determined for each. Some suppliers have published data indicating the effect of dispersant on various types of coating colors (*6, 7*), but, in general, it may be said that

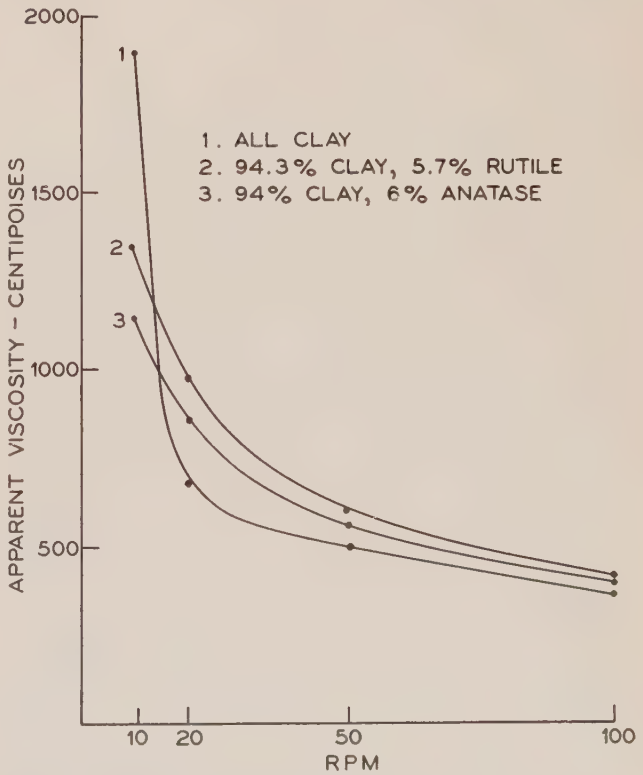


Fig. 11. Effect of pigment composition on viscosity of casein colors (47% total solids)

the selection of a dispersant and the proper amount to be used for a specific color are still probably on rather a hit-or-miss basis.

EFFECT OF COMPOSITION

Much of the foregoing information has indicated, as would be expected, that the composition of a coating color has a definite effect on its rheological properties. This has been affirmed by work previously published which gave several interesting conclusions as regards clay colors (*4*). Here it was shown that in the case of clays produced from two different crudes with the fineness regulated by separation to give 70, 80, and 90% under 2-mu particle size the clays with the highest proportion below 2 mu gave the more viscous colors using either starch or casein as the vehicle, that is the finer clays produced the more viscous mixtures. Confirming data were obtained by determining the viscosity of casein colors made with varying fractions of a coarse and fine clay in which the color made from all coarse clay gave much lower viscosity than the color made from all fine clay, with the various fractions falling in between. The same article (*4*) showed that viscosity increased with increasing adhesive ratio for both starch and casein.

An example of how a relatively slight difference in pigmentation may affect the rheological properties of coating colors is shown in Fig. 11. These colors were all of 47% total solids, made with 13% casein ratio with 0.3% sodium hexametaphosphate as the dispersant. The pigmentation in one was all clay, in another 94.3% clay and 5.7% of a rutile-titanium dioxide of the non-water dispersible type, while the third was 94% clay and 6% water dispersible anatase-titanium dioxide. The thixotropy of the color made with all clay was considerably greater than for the other two colors although the "apparent viscosity" at the highest rates of shear was slightly lower.

CONCLUSIONS

The foregoing discussion has served to demonstrate the great complexity of coating color systems, a point which is generally acknowledged. This complexity is readily explained on the basis that coating colors represent crowded particle systems, the degree of crowding depending on the total solids. Unless exceedingly dilute, coating colors are rarely Newtonian in behavior, that is with the flow directly proportional to the shearing force. Instead, coating colors usually exhibit plastic, pseudoplastic, thixotropic or dilatant flow and in fact most are thixotropic. The thixotropic phenomenon can probably be explained on the basis of structure existing in the system, which structure has rigidity. This structure must be broken by the application of a shearing force before flow is produced. The flow is only maintained during the application of the shearing force and when it is removed the structure again reforms.

Since coating colors are not Newtonian in nature but exhibit important rheological characteristics such as thixotropy, it would seem logical that single point measurements yielding only "apparent viscosity," that is the rate of flow under one specific shearing condition, are not satisfactory. Shearing stresses vary with different types of coating machines and even vary at different points in the same coating operation. Therefore, even granting that present multipoint viscometry techniques do not simulate actual coating conditions, they do serve to give a much better picture than singlepoint viscometry.

By using a simple multipoint method of viscometry an indication, at least, can be obtained of the effect of various factors on the rheological characteristics of coating colors. Even such indications might well offer possibilities of correlation with actual operating practice.

This point is important because even slight variations in the components of a coating color produce marked differences in rheological characteristics. For example, a slight difference in total-solids content makes a marked difference in flow, but the effect of dilution varies with different colors. Some colors remain practically unchanged on storage, others body appreciably while still others thin down. The effect of dispersants varies with different colors and the amount and type to give minimum viscosity with one color probably would not be the optimum for another color. Slight differences in pH produce considerable difference in rheological properties. Even if other factors are maintained constant, rather slight differences in pigment composition have a marked effect.

When it is considered that even in a simple formulation such as a color composed of pigment, dispersant, adhesive, and water, the variation of one of the components gives a marked variation in rheological characteristics it may well be realized that the variation of more than one will increase the possibilities immensely. Furthermore, the use of additives—e.g., plasticizers, emulsions, preservatives, antifoamers and dyestuffs—may also have an effect.

While it is true that no general rules can be laid down for the way certain factors may affect the rheological characteristics of coating colors, and that a given variation may affect one coating color in a different manner than another, a study of how such factors affect a specific color for coating by a given process should lead not only to the development of a more satisfactory coating but also should furnish means of control. For this reason the application of presently available multipoint viscometry techniques, and the development of new ones more closely simulating operating practice, have much to offer the paper coating industry.

LITERATURE CITED

1. Lyons, S. C., TAPPI Monograph Series No. 7 "Pigments for Paper Coating," Chapter 7 "Paper Coating Clays," pp. 71–76 (1948).
2. Green, Henry, "Industrial Rheology and Rheological Structures," Chapters 1 and 2, John Wiley & Sons, Inc., New York (1949).
3. Green, Henry, "Industrial Rheology and Rheological Structures," Chapters 4, 5, 6, and 7, John Wiley & Sons, Inc., New York (1949).
4. J. M. Huber Corp., New York, N. Y., "Kaolin Clays and Their Industrial Uses," Chapter 13 "Coating Grade Clays" (1949).
5. Asdell, Bernard, K., *Tech. Assn. Papers* 31: 193–197 (1948).
6. American Cyanamid Co., New York, N. Y., Tech. Bulletin No. 21 "Azite Liquefier 900."
7. Calgon Inc., Pittsburgh, Pa., "Calgon Data for the Pulp and Paper Chemist."

Received Jan. 6, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 20–23, 1950.

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Henry J. Abernathy, Mill Manager, National Folding Box Co., Inc., New Haven, Conn.

Louise Allen, Librarian, Crown Zellerbach Corp., Central Research Dept., Camas, Wash., a 1934 graduate of the University of Michigan.

Carl B. Barnes, Head, Pulp and Paper Group, U. S. Army, Economic & Scientific Section, GHQ, SCAP, Tokyo, Japan.

Richard T. Barnes, Jr., Sales Engineer, The International Nickel Co., Inc., New York, N. Y., a 1930 graduate of Massachusetts Institute of Technology.

Charles P. Bean, Chief Chemist, East Lancashire Paper Mill Co. Ltd., Radcliffe Lancashire, England, a 1925 graduate of Manchester University, with a Ph.D. degree from Leeds University in 1928.

John C. Benny, Assistant Technical Director, The Diamond Match Co., Pulp and Paper Div., Plattsburg, N. Y., a 1934 graduate of Dalhousie University.

James Boyd, President, Manchester Machine Co., Middletown, Ohio, a 1918 graduate of Pratt Institute.

Harry E. Connors, Jr., Development Engineer, B. F. Goodrich Chemical Co., Cleveland, Ohio, a 1943 graduate of the University of Minnesota.

Robert A. Davis, District Engineer, Chicago Bridge & Iron Co., Birmingham, Ala.

P. F. Della Luna, Laboratory Director, The Stevens Paper Mills, Inc., Westfield, Mass., a 1941 graduate of Holy Cross College.

Frederick M. Dierks, Dierks Lumber & Coal Co., Kansas City, Mo., a 1942 graduate of Massachusetts Institute of Technology.

Raymond W. Geiser, Chief Chemist, Quaker State Oil Refining Co., Emlenton, Pa., a 1938 graduate of Grove City College.

Ralph S. Grant, Project Chemist, Pulp Div., Weyerhaeuser Timber Co., Longview, Wash., a 1948 graduate of the University of Kansas.

James T. Gresham, Development Engineer, Kimberly-Clark Corp., Neenah, Wis., a 1941 graduate of Detroit Institute of Technology.

Russell C. Grimshaw, Student, New York State College of Forestry, Syracuse, N. Y.

Paul Hain, Research Chemist, The Champion Paper & Fibre Co., Hamilton, Ohio, a 1941 graduate of Miami College.

William A. Healy, Director, Div. of Sanitary Engineering; Technical Secretary of Water Pollution Commission, State Health Dept., Concord, N. H., a 1936 graduate of Massachusetts Institute of Technology.

Judson H. Holloway, Jr., Research Chemist, Rayonier, Inc., Shelton, Wash., a 1924 graduate of the University of Denver, with an M.S. degree in 1926, and a Ph.D. from the University of Illinois in 1932.

Reginald F. G. Holness, Chief Chemist, Waterlow & Sons Ltd., London, E. C. 2, England, a 1935 graduate of London University.

John J. Hyslop, Analytical Chemist, Weyerhaeuser Timber Co., Pulp Div., Longview, Wash., a 1948 graduate of Oregon State College.

Virginia Jackson, Librarian, Agricultural Experiment State, Purdue University, Lafayette, Ind., a 1949 graduate of the University of Wisconsin.

Robert J. Jacobs, Assistant Chief Engineer, Dilts Machine Works, Div. of Black-Clawson Co., Fulton, N. Y., a 1942 graduate of City College of New York.

Donald F. Jenkins, Student, New York State College of Forestry, Syracuse, N. Y.

Meder Johnson, Sales Engineer, James Brinkley Co., Seattle, Wash. Attended the University of Washington.

Harold M. Johnston, District Representative, General Mills, Inc., Minneapolis, Minn., a 1926 graduate of Dartmouth College.

Harold R. Joiner, Research Chemical Engineer, The Champion Paper & Fibre Co., Hamilton, Ohio, a 1933 graduate of the University of Cincinnati.

Chester A. Jones, Research Chemist, The Champion Paper & Fibre Co., Hamilton, Ohio, a 1921 graduate of Pennsylvania State College.

Donald T. Jones, Staff Engineer, Atlantic Refining Co., Philadelphia, Pa., a 1943 graduate of Pennsylvania State College.

James E. Kearney, General Manager, Swenson Evaporator Co., Harvey, Ill., a 1932 graduate of the University of Missouri.

Norwood H. Keeney, Jr., Graduate Student, University of Maine, Orono, Me., a 1948 graduate of Trinity College.

Geza Kelemen, In charge of Pulp and Paper Mill, Punalur Paper Mills, Ltd., Punalur, Travancore Indian Union, a 1926 graduate of Technische Hochschule, Darmstadt.

Thomas M. Kettles, Manager, Canadian Stebbins Engr. & Mfg. Co. Ltd., Montreal, P. Q., Canada, a 1935 graduate of Clarkson College.

Edward G. Kirby, Assistant Manager, Price & Pierce Ltd., Montreal, P. Q., Canada, a 1933 graduate of McGill University.

Paul J. Klein, Design Engineer, Kimberly-Clark Corp., Neenah, Wis., a 1944 graduate of Marquette University.

Gustav F. Klingstedt, Chief of the Main Laboratory, Kymmene Aktiebolaget, Kuusankoski, Finland, a 1932 graduate of Abo Academy, Finland.

John J. Knewstubb, Research Chemist, Australian Paper Mfrs. Ltd., Melbourne, Australia, a 1932 graduate of the University of Otago, New Zealand.

Hans P. F. Kotte, Technical Editor, Allgemeine Papier-Rundschau, Alfeld/Leine, Germany, a 1923 graduate of Technical University, Berlin.

Maung Ba Kyi, Student, New York State College of Forestry, Syracuse, N. Y.

Robert H. Lalk, Chemist, Dow Chemical Co., Midland, Mich., a 1941 graduate of the University of Wisconsin.

Robert L. Leaf, Jr., General Foreman, Mill Finishing Dept., The Ohio Boxboard Co., Rittman, Ohio, a 1945 graduate of the University of Wisconsin with a Ph.B. degree, and a 1945 graduate of the Institute of Paper Chemistry with an M.S. degree.

Yih Hung Lee, Graduate Student, University of Maine, Orono, Me., a 1947 graduate of the University of Utopia.

Otto Mass, General Director, Pulp and Paper Research Institute of Canada, Montreal, P. Q., Canada, a 1911 graduate of McGill University.

Arthur W. Martin, Technical Superintendent, Australian Paper Mfrs. Ltd., Sydney, N. S. W., Australia, a 1936 graduate of the University of Melbourne.

Harry V. Miles, Jr., Manager of Research and Development, Honan-Crane Corp., Lebanon, Ind., a 1936 graduate of Ohio State University.

Oerten O. Nadebaum, Technical Superintendent, Australian Paper Mfrs. Ltd., Maxwell, Victoria, Australia, a 1933 graduate of the University of West Australia.

Jerry S. Nickerson, Student, University of Maine, Orono, Me.

Curt C. Pearl, Research and Quality Control Manager, Equitable Paper Bag Co., Inc., Long Island City, N. Y., a 1939 graduate of Wuerzburg College, Germany.

Pecorini Dario, Engineer, Cartiere Burgo S. A., Torino, Italy, a 1941 graduate of Politecnic College of Torino.

Oliver S. Plantinga, Director of Research on Cotton and Gauze Products, Johnson & Johnson, New Brunswick, N. J., a 1928 graduate of the University of Massachusetts with an M.S. degree in 1930, and a Ph.D. degree from New York University in 1934.

Howard A. Raymond, Jr., Sales Engineer, Plaskon Div. Libbey-Owens-Ford Glass Co., Toledo, Ohio.

Thomas L. Reiling, Sales Engineer, Brown Co., Chicago, Ill., a 1939 graduate of the University of Dayton.

Roland O. H. Runkel, Chief of Chemistry Div., Zentralanstralt fur Forst-und Holzvirtschaft, Reinbek (Gz. Hamburg), Germany, a 1920 graduate of University Freiburg.

Carl H. Scheman, Contracting Engineer, Chicago Bridge & Iron Co., New York, N. Y., a 1918 graduate of Iowa State College.

James R. Schoettler, Student, Institute of Paper Chemistry, Appleton, Wis., a 1946 graduate of Purdue University.

Edward B. Schon, Laboratory Assistant, Aetna Paper Co. Div., Howard Paper Mills, Inc., Dayton, Ohio.

Raoul Simoneau, Librarian, Donnacona Paper Co. Ltd., Donnacona, P. Q., Canada. Attended Beauceville College.

Robert W. Smith, Chief Chemist, Fairfield Mill, Australian Paper Mfrs. Ltd., Melbourne, Victoria, Australia, a 1934 graduate of Melbourne University.

Miriam S. Vincent, President, George Vincent, Inc., New York, N. Y. Attended Hunter College.

Robert W. Wagner, Cooperative Student, University of Cincinnati and Container Corporation of America, Circleville, Ohio.

William E. Wanstall, Sales, Reichhold Chemicals, Inc., Elizabeth, N. J.

Axel G. Westberg, Chemical Engineer, Patent Office Library, Stockholm, Sweden, a 1917 graduate of Kungliga Tekneska Hogskolan, Stockholm.

TAPPI Notes

J. Benjamin Beck, formerly of the E. B. Eddy Co., is now General Superintendent, Oregon Pulp and Paper Co., Salem, Ore.

M. P. Bhargava, formerly of the Forest Products Research Institute is now with the Star Paper Mills, Ltd., Saharanpur, U. P., India.

A. L. M. Bixler, is now Superintendent of the Warren Mill, Riegel Paper Co., Riegelsville, N. J.

O. W. Callighan is now Manager of Special Accounts, Edgar Bros. Co., Kalamazoo, Mich.

C. W. Converse is now Manager of the Pulp and Paper Mill Div., Sprout, Waldron & Co., Muncy, Pa.

R. A. Diehm is now Executive Vice-President and General Manager of the Ward Paper Co., Merrill, Wis.

J. C. W. Evans is now Associate Editor, Pulp and Paper Magazine of Canada, Gardenvale, P. Q.

Thomas Foulkes is now Steam and Power Engineer for the E. B. Eddy Co., Hull, P. Q.

Kenneth M. Grasse, formerly of the Consolidated Water Power & Paper Co., is now Pulp and Paper Technologist, Economic Cooperation Administration, Washington, D. C.

M. A. Hadi is now In Charge of Controla and Research, Sirpur Paper Mills Ltd., Hyderabad, (Deccan) India.

K. M. Paul Hsi, formerly of the University of Maine is now Engineer for the St. Regis Paper Co., Deferiet, N. Y.

A. S. Kadzielawa is now Control Superintendent, Brompton Pulp and Paper Co., Red Rock, Ont.

William S. Kennedy, formerly of the Paul Valve Corp., is now Sales Manager, Hasco Valve & Machine Co., Milwaukee, Wis.

A. Thomas Luey, formerly of the American Coating Mills is now Engineer, Technical Dept., Sutherland Paper Co., Kalamazoo, Mich.

W. W. Marteny is now In Charge of Technical Control, National Container Corp. of Wis., Tomahawk, Wis.

F. S. McCall is now Superintendent, Mill Technical Dept., Union Bag & Paper Corp., Savannah, Ga.

Gilbert Mason is now Vice-President Edgar Bros. Co. Metuchen, N. J.

Donald H. Newcomb is now Director of Control, Riegel Paper Co., Milford, N. J.

Bengt Niberger, formerly of Castle & Overton, Inc., is now Head, Service and Development Dept., Spencer, Lock & Co., Ltd., London, Eng.

J. Raymond Sanborn, formerly of Syracuse University is now Technical Director, National Aluminate Corp., Chicago, Ill.

E. Schoenberg, formerly of the Shree Gopal Paper Mills Ltd., is now Technical Consultant, F. W. Heilgers & Co., Ltd., Calcutta, India.

Saul M. Silverstein, President of the Rogers Corp., is now also the Vice-President of the First National Bank of Manchester (Conn.).

Vernon L. Tipka is now Secretary-Treasurer, News Print Service Bureau, New York, N. Y., succeeding R. S. Kellogg who has retired and now lives in Bradenton, Fla.

Everett C. Uebrich, formerly of the Port Huron Sulphite & Paper Co., is now Sulphite Superintendent, St. Croix Paper Co., Woodland, Me.

Carl A. Von Ende is now Asst. Manager of Manufacturing Gilman Paper Co., Cellucord Corp., and the Kraft Bag Corp., Gilman, Vt.

John O. Younger, formerly of the Munising Paper Co., is now Chemist for the Empire Box Co., Stroudsburg, Pa.

Edgar R. Zimmerman is now Technical Service Representative, Paper Sales Div., Minnesota & Ontario Paper Co., Minneapolis, Minn.

* * *

Palmer J. Lathrop, President of the Cameron Machine Co. Brooklyn, N. Y., has succeeded Joseph Scheuermann as official representative of his Company in TAPPI.

Audenried Whittemore is now the official representative of Paper & Industrial Appliances, Inc., in TAPPI.

Industry Notes

Harold F. Merritt has been appointed Executive Vice-President of the Solvay Sales Div., Allied Chemical & Dye Corp., New York, N. Y.

* * *

The Paper & Pulp Testing Laboratories, 118 E. 28th St., New York, N. Y., has been certified by the Certified Pulp Testers Bureau. The Laboratory is being operated by William Landes who is a 1930 graduate of the New York State College of Forestry.

* * *

D. B. Smith, formerly President of the Ward Paper Co., is now President and General Manager of Wausau Paper Mills, Brokaw, Wis.

* * *

A new paper machine, a development of the Research and Engineering Departments of the Champion Paper & Fibre

Why **MILL** *after* **MILL** *after* **MILL**

is putting in

BIRD JONSSON SCREENS

— as knotters, Jonsson Screens are delivering 80 to 100 tons of clean sulphite a day, handling stock up to 1½% consistency; on groundwood and kraft they're delivering 150 tons or more and handling stock up to 2½%.

— as fine screens, using slotted plates, Jonsson Screens are doing a whale of a job and providing great capacity at lower cost.

— ahead of brown stock washers, Jonsson Screens are taking out the knots, shives and chips, delivering the stock without foaming problems and assuring increased washing efficiency, better vacuum maintenance and maximum recovery of black liquor.

— on waste paper stocks, Jonsson Screens remove wet strength paper, cellophane, string, paper clips, rubber bands, etc., with negligible loss in the tailings. Capacity is large.

For information as to what Jonsson Screens can do for you, write

BIRD MACHINE COMPANY

SOUTH WALPOLE • MASSACHUSETTS

Co., is now in operation at the Pasadena, Texas, mill of the Company. This machine is designed to produce high-quality machine-coated grades at speeds up to 1200 feet per minute at 135-inches trim. After the break-in period the machine will make 60 to 70 tons of paper per day, increasing the entire mill capacity to 350 tons per day on these fourdriniers and two cylinder machines. The supercalender stack was constructed by the Appleton Machine Co., Appleton, Wis. An addition of 150 employees will be employed by the Houston Division to staff this machine and its supplementary equipment.

* * *

The Sherbrooke Machineries Ltd., Sherbrooke, Quebec, has announced the appointment of T. W. Toovey as development engineer. Recently, Mr. Toovey was with the Pennsylvania Salt Mfg. Co. He was formerly consultant for Harmanetzer Papierfabrik, Harmanec, Czechoslovakia. Mr. Toovey is well known for his studies of pulp bleaching procedures.

* * *

J. S. Scheuermann and T. N. Carter, formerly of the Cameron Machine Co., have become associated with the Bagley & Sewall Co., Watertown, N. Y., and will handle the development and sales of slitting, winding, laminating, and converting machinery of the company.

* * *

The De Laval Steam Turbine Co., Trenton, N. J., has recently issued Bulletin 1100 Pumps for Pulp and Paper Mills. The stock pumps range in capacity from 5000 gpm at heads to 130 feet to 2500 gpm at heads of 150 feet; the white water pumps to 5500 gpm at heads to 140 feet.

* * *

The Glyco Products Co., Brooklyn, N. Y., has issued two catalogs: Esters by Glyco and Synthetic Waxes by Glyco.

* * *

Wyandotte Chemicals Corp., Wyandotte, Mich., has developed a new inhibited detergent (Wyandotte Dural H and M) for washing glassware. The solution is claimed to cause glass etching 2 to 33 times slower than the commonly used detergents now on the market.

* * *

The J. O. Ross Engineering Corp., 350 Madison Ave., New York, N. Y., has prepared a new supply of the Ross Psychrometric Chart which may be obtained upon request. This chart is probably the only one specifically designed for the range needed for paper mills.

* * *

The Curlator Corp., 565 Blossom Road, Rochester 10, N. Y., has issued Bulletin C-2. This bulletin covers the origin, development, and operation of the Model C-50 Curlator. It shows how tear, tensile, burst, porosity, softness and stretch are affected by curlation.

* * *

Alfred G. Blake has been elected Vice-President in Charge of Sales for Edgar Bros. Co., Metuchen, N. J. Mr. Blake is a graduate of Lehigh University and was, until recently, one of the partners in the firm of Rogers & Slade, management consultants of New York City.

Robert V. Dilley was named Manager of Specialty Sales and Asst. Secretary of the Company.

The fourth National Convention of the American Society for Quality Control will be held at Milwaukee, Wis., on June 1–2, 1950. Details may be obtained from A. D. Wolvin, R. R. Donnelley & Sons Co., 350 E. 22nd St., Chicago, Ill.

* * *

The Lowell Textile Institute, Dept. of Paper Engineer will give a summer course in "Paper—Its Properties and Uses" on June 5–16, 1950. The course is sponsored by the Boston Paper Trade Association. Enrollment is limited. The fee for the course, including tuition, room, meals, and transportation on field trips, etc., is $125. Applications and inquiries should be sent to Professor Geoffrey Broughton, Lowell Textile Institute, Lowell, Mass.

* * *

Another research project enlisting university scientists in the problems of reducing stream pollution was announced today by the Sulphite Pulp Manufacturers' Research League This is the fifth such project undertaken in recent months.

A cash grant has been made by Hoberg Paper Mills, Green Bay, Wis. to the National Resources Research Institute at the University of Wyoming to establish a research fellowship. Under this grant, the western university will do research into the possible commercial use of spent sulphite liquor and of torula yeast plant effluent as binders for making coal dust into fuel briquets. It also is hoped that the study will yield results which will prove valuable in iron ore briquetting and in road surface binding. Any results attained will be made available for use by all members of the League.

Developments of past weeks indicate that in the near future some Wisconsin sulphite pulp manufacturers may build torula yeast plants for processing spent sulphite liquor. The torula yeast process reduces the oxygen-consuming characteristics of the liquor thus treated, and in this way lessens its harmful effects upon fish and other aquatic life in the stream.

But certain compounds present in the spent liquor can be processed with yeast, and after it has been treated the remaining liquor still must be disposed of. With commercial scale yeast plants in the offing, how to dispose of the yeast-process effluent becomes a problem. Recent reports of tests made by the Green Bay Metropolitan Sewerage District are that it does not respond satisfactorily to conventional sewage treatment processing.

Preliminary work with this material from the sulphite industry's experimental yeast plant at Rhinelander indicates that yeast-plant effluent may prove very useful as a binder. Consequently this will be studied at the University of Wyoming.

Spent sulphite liquor is already being utilized during the summer months in several Wisconsin areas to give a dust-free and better wearing surface on gravel roads. The sulphite pulp mills supply the material to county and township road officials without charge. The public officials haul it away and flow it onto their roads. When it dries, it provides a surface resembling black top at a cost substantially lower than permanent paving, the road districts report.

* * *

Progress in modern bleaching methods and equipment can be traced in the history of bleaching over the past 30 years. Up until 1920 the bleaching process was generally carried out in batches, mostly in beaters or in specially designed tanks much as Fletchers or Bellmers. The period 1920 to 1930 was characterized by the progress of two-stages hypochlorite bleaching, and simultaneously by the introduction of the continuous method of bleaching.

NOPCO KFS* CUTS FOAM

ALL ALONG THE LINE

Wherever foaming occurs—on screens, in rifflers and washers, and on paper machines—you'll find Nopco's newly-developed KFS an outstanding foam killer. It practically eliminates obstinate foam conditions within a *matter of minutes.*

If results with defoamers you have already used have not proved satisfactory, it is very probable that KFS is the one you are seeking. For this new foam destroyer is stable to chemicals such as alum and chlorine, and to hard water. It can do a real job *all along the line,* no matter how great the volume or speed of production.

IN THE PULP MILL

Added to digester effluent, KFS cuts foam to negligible proportions.

Added to bleach plant effluent, which contains chlorine-lignin combinations and foams heavily, KFS does an exceptional job of foam control—making it easy to dispose of waste liquors.

Added to stock immediately before it passes through screens, rifflers and washers, KFS prevents foam formation during processing.

IN THE PAPER MILL

When added to stock just preceding any point where foaming occurs, KFS dissipates foam effectively. Thus foaming can be eliminated on the screen, in the vat, or on the wire. The results are: better fibre dispersal, reduced breaks, *improved sheet formation.* In addition, higher machine speeds are made possible *without sacrifice of quality.*

Nopco KFS is easily made into a stable emulsion, by agitation with a paddle. Order enough for a trial run—and see for yourself how advantageous this new defoamer can be.

NOPCO TRADEMARK EVOLVED THRU RESEARCH

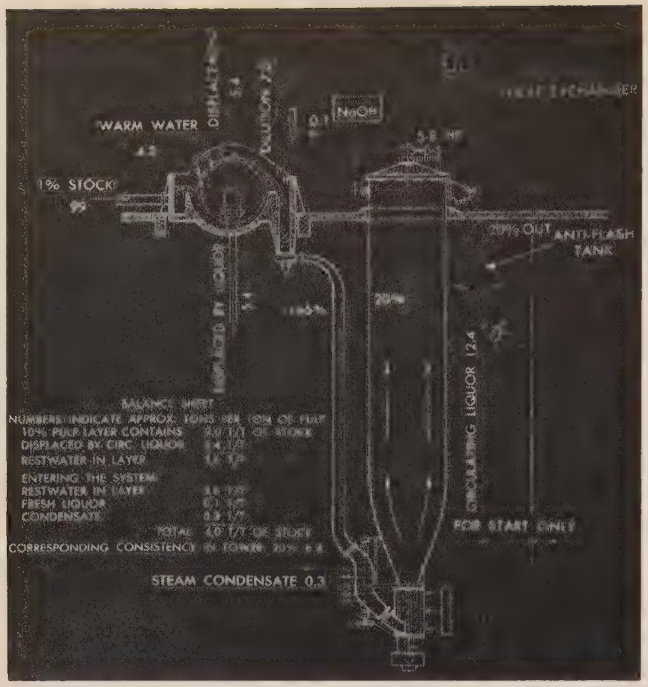
NOPCO CHEMICAL COMPANY

Formerly National Oil Products Company

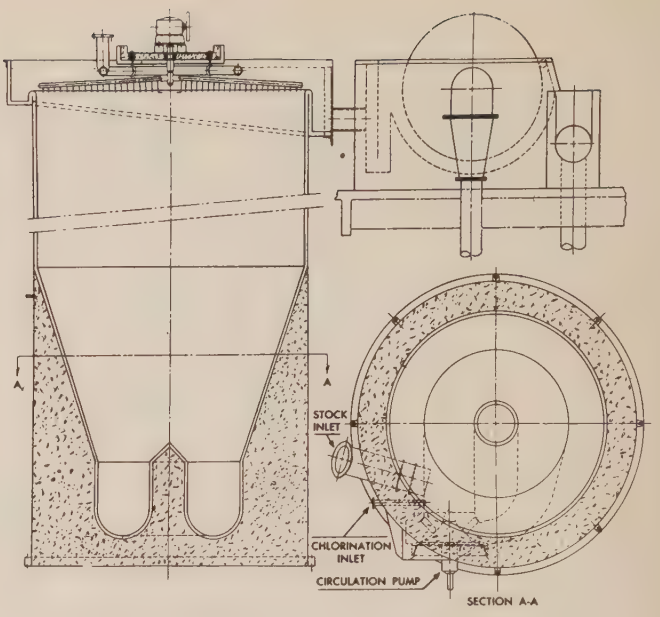
HARRISON, NEW JERSEY

Branches: Boston, Chicago, Cedartown, Ga., Richmond, Calif.

*Reg. U. S. Pat. Off.



Standard high-density tower with preimpregnation



Low-density tower (chlorination)

Until 1930 the progress of the bleach industry can be characterized as a steady slow evolution. Since then the progress has been quite revolutionary. First came the introduction of direct chlorination, followed by caustic extraction at high temperatures, acid treatment, chlorine dioxide treatment, and finally resulting in actual installations comprising six to eight successive stages so that the bleaching of Kraft resulted in a color comparable to that of sulphite without reducing the strength of the fibers.

Kamyr attacked the problem of pulp bleaching at a time when direct chlorination first made its appearance on an industrial scale. They effectively made their start by introducing specially designed circulation pumps for stock chests and bleachers.

The soundness of Kamyr's theories, developed and applied during the pioneering days in pulp bleaching, has been proved by their adoption throughout the trade. This is particularly true of Kamyr's emphasis upon the desirability of the separate washing after each treatment. For many years Kamyr bleaching methods and equipment have so capably demonstrated the advantages of the multiwashing process that today the separate washing after each treatment is a standard procedure in all modern bleaching.

Chlorination Tower

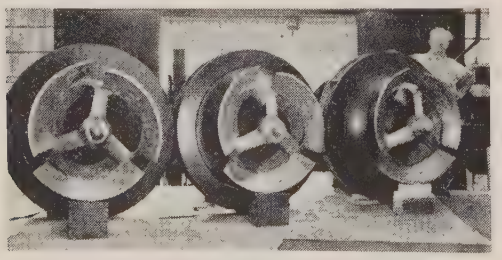
One of Kamyr's features is their method of continuous chlorination. The problem of efficient mixing and absorption of chlorine, either as a gas or as a chlorine water is a serious one. The usual method of mixing by admitting chlorine into a turbulent flow of pulp through a mixer or transport pump did not offer an equalizing effect equivalent to the kind established by recirculation in the batch type chlorinator; nor could it sufficiently assure the constant flow of stock over the whole section of the reaction tower.

Kamyr solved this problem of chlorine mixing in a simple and efficient manner by placing a standard Kamyr (Type CR) circulation pump at the base of the tower. This bottom, shaped as an open, ring-like channel was thus converted to a mixing chest. The pumps are of either rubber covered or stainless steel construction to resist the corrosive effects of chlorine and hydrochloric acid.

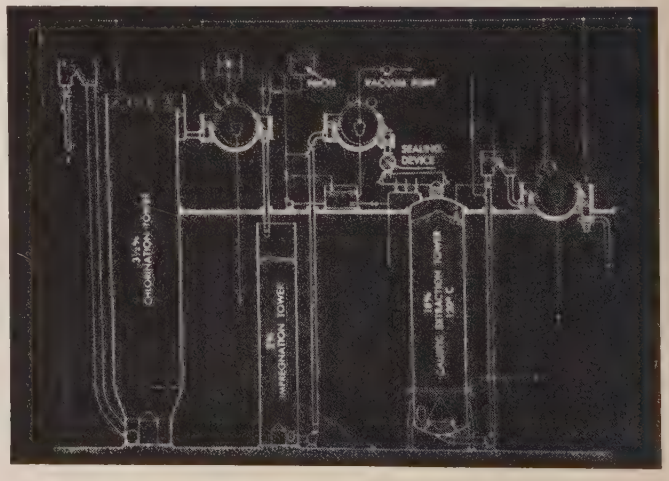
The inlet and outlet of the pumps are connected tangentially to produce a strong horizontal circulation. With this active circulation localized at the bottom of the tower, the chlorine is thoroughly mixed into the pulp which rises without further agitation to the top of the tower and flows to the following washer. The circulation flow of stock through the chlorination pump amounts to 10 to 15 times the continuous flow through the system.

Sandy Hill-Kamyr Standard High-Density Tower

The Kamyr chlorination tower has been successively adapted for hypochlorite or alkali treatments at 7–9% consistency or for acid treatment usually at 5% consistency. For handling stock of high density, this tower is distinguished from ordinary towers by the fact that the high-density stock floats on low density stock kept in circulation by a special



Circulation pumps, type CR

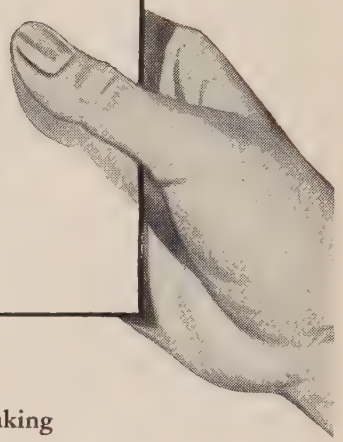


Preimpregnation system

For Paper-Making...

Quality Chemicals

PLUS!



SOLVAY

Trade-Marks SOLVAY and Registered U.S. Pat. Off.

LIQUID CHLORINE

CAUSTIC SODA

SODA ASH

When you specify SOLVAY for your paper-making chemicals . . .

You get the benefit of SOLVAY's long experience as a manufacturer of chemicals for paper making. SOLVAY has worked with paper makers for more than five decades—longer than any other alkali manufacturer!

You get prompt delivery of the chemicals you need from one of the huge SOLVAY plants or from a near-by warehouse.

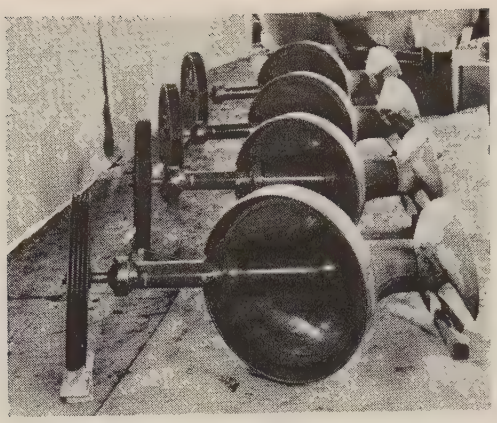
And—you get the valuable services of the skilled paper experts who are part of SOLVAY Technical Service . . . men who know your industry and its problems.

All this—plus the traditional quality which SOLVAY puts into every product—is yours when you specify SOLVAY.

SOLVAY SALES DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

BRANCH SALES OFFICES:
Boston • Charlotte • Chicago • Cincinnati • Cleveland • Detroit • Houston
New Orleans • New York • Philadelphia • Pittsburgh • St. Louis • Syracuse

Soda Ash • Caustic Soda • Caustic Potash • Chlorine • Potassium Carbonate
Calcium Chloride • Nytron • Sodium Bicarbonate • Specialty Cleansers
Ammonium Bicarbonate • Sodium Nitrite • Para-dichlorobenzene
Ortho-dichlorobenzene • Monochlorobenzene
Methanol • Ammonium Chloride
Formaldehyde



Circulation pumps, type CT

(Type CT) pump of the tangential type. The high density pulp moves downward by gravity and floats on a field of low density pulp thereby preventing any chance of channeling or drainage. The stock is thinned by automatically operated dilution nozzles placed above the bottom circulation.

The equalizing effect of this bottom circulation makes it possible for pulp to be withdrawn regularly to the following stage by means of a transport pump, with no need for a separate mixing chest. The final density in the tower may, for caustic extraction, reach 20–22%, and the temperature in the tower will not exceed 100°C.

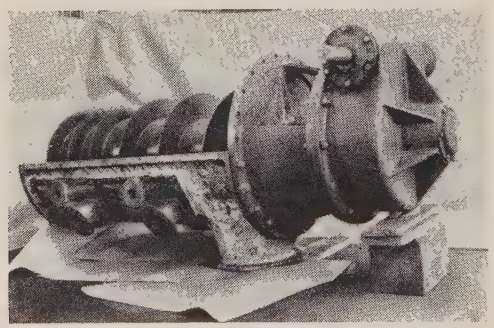
In this high-density tower the pulp moves from the bottom of the tower upward. The mixing and heating of the pulp takes place at low density. The pulp is thickened up to 20% in the concentrator.

Surplus liquor is returned from the Concentrator at the bottom of the reaction tower and goes partly for displacement, on the vacuum washer, partly for dilution. The density of the stock moving upward in the tower is adjusted solely by regulating the quantity of displacement liquor on the washer. The high-density pulp is extracted from the top of the tower without any dilution, but showers may be used when temperature is below 100°C.

An antiflash tank placed at the outlet of the tower will successfully handle temperatures up to 125°C. or more without danger of eruption at the top.

Preimpregnation Process

The Kamyr patented process for pre-impregnation of high-density pulp assures excellent impregnation, a more uniform pulp, a higher alpha content, and an increased yield. A steam trap or sealing device operating in conjunction with the feeding device on top of the high-density tower permits stock



Concentrator screw, laying on side with half cover removed

to be handled at temperatures of 100°C. or higher. This system is designed especially for the production of the highest quality pulp such as is required for the best grades of rayon.

Further details on these processes are obtainable from the Sandy Hill Iron & Brass Works, Hudson Falls, N. Y., which is the sole licensee in the United States for sales and manufacture of Kamyr equipment.

EMPLOYMENT SERVICE

Positions Open

P57-50. Chemist. Eastern paper converter desires services of a chemist with paper mill or converting experience for research on adhesive paper coatings. Please submit complete record.

P58-50. Chemist. Experience in cotton pulps manufacture preferred. Should also have had some paper mill experience. Midwest company making cotton, rag, and special market pulps.

P59-50. Physical testing specialist. At least four years' experience in paper testing. Write for details to Arthur J. Jones, Chief, Employee Utilization Branch, Personnel Office, Philadelphia Quartermaster Depot, U. S. Army, 2800 South 20th Street, Philadelphia 45, Pa. Salary $4200–4950 with annual Civil Service increases of $125.

P60-50. Southern paper manufacturer expanding technical services is interested in considering applications for the following positions as specified:

General Engineering Position Specification. Graduate engineer, or equivalent study and practical experience. Under 38 years of age. Physically qualified to work around moving machinery. Congenial and effective personality. Minimum of three years practical experience, at least one being in responsible charge. Ability to produce working drawings quickly is essential, administrative ability highly desirable.

Power Engineer. Work consists of study, design, layout, erection, operation and maintenance of steam and electrical generation, and distribution systems and equipment.

Pulp Mill Engineer. Work consists of study,design, layout, erection, operation and maintenence of sulphate process pulp systems and equipment.

Paper Mill Engineer. Work consists of study, design, layout, operation and maintenance of Fourdrinier paper-machine systems and equipment.

Chemical Engineer. Work consists of study of sulphate process unit operations to improve efficiency. Practical experience in instrumentation highly desirable.

Quality Inspector. Minimum five years' experience in paper manufacture, at least two years being in responsible charge statistical probability quality control system.

Engineering Cost Estimator. Minimum three years' experience in estimating costs of plant construction and maintenance jobs.

Salaries equal or better industry average proportional to effective ability. Applicants should state education, experience and earnings in detail, enclosing samples of work where appropriate. Picture of applicant is desirable. Applications will be treated as strictly confidential unless applicant expressly authorizes reference check. All correspondence and exhibits will be returned within two months. Applications received after 30 days after publication date probably will not be considered.

These positions offer an unusual opportunity for men who sincerely intend to develop their value in the paper industry to the maximum. Possibility of eventual advancement to management positions is excellent.

P61-50. Research Director, Ph.D. in Chem. Eng. to offer a limited amount of graduate course work in pulp and paper technology and to direct theses for Master's and Doctor's degrees in chemical engineering. Apply to: W. H. Beisler, University of Florida, Gainesville, Fla.

Positions Wanted

E65-50. Chemical engineer, 34, family, desires position in technical sales with a company selling products or equipment to the pulp and paper industry. Presently employed as sales engineer. Has wide acquaintance in the paper industry. Ten years' diversified experience in technical sales, research, and development.

E66-50. Chemist, 28. Experience in defoaming and sizing fields. New York State College of Forestry pulp and paper graduate. Desires position as chemist in pulp or paper mill.

E67-50. Mill manager with 20 years' experience in light weight papers desires change to a progressive mill. Has practical and technical knowledge in producing these grades from all types of fiber. Color experience excellent.

Famous trademarks in paper

Known throughout the Paper Industry are the familiar trademark of the Kalamazoo Paper Company and the slogan, "Good paper since 1867." Today, the Kalamazoo Company comprises three paper mills and two coating mills, producing more than 225 tons of finished products every day. Specialized Kalamazoo grades include Book, M.F. Label, Offset and Writing, Coated Book and CIS Label papers.

...and paper making chemicals

For many years, Wyandotte Chemicals Corporation has made a business of developing and supplying chemicals designed to meet the Paper Industry's most exacting requirements.

One such chemical is Wyandotte Precipitated Calcium Carbonate, a unique paper-coating pigment known for its smooth texture and high whiteness. When used in the coating formula, this refined, uniform product helps furnish a superior sheet with good opacity, ink absorption and printing qualities. Its complete freedom from grit and abrasives insures a bright, smooth coating that will not affect printing rolls. And it has the characteristics desirable for "on-the-machine" or "off-the-machine" coating.

Why not get *all* the facts on Wyandotte Precipitated Calcium Carbonate? Write today for complete information and technical data.

Wyandotte Chemicals Corporation
Wyandotte, Michigan • *Offices in Principal Cities*

SODA ASH • CAUSTIC SODA
BICARBONATE OF SODA
CALCIUM CARBONATE • CALCIUM CHLORIDE
CHLORINE • HYDROGEN • DRY ICE
SYNTHETIC DETERGENTS • GLYCOLS
CARBOSE (Sodium CMC) • ETHYLENE DICHLORIDE
PROPYLENE DICHLORIDE
AROMATIC SULFONIC ACID DERIVATIVES
OTHER ORGANIC AND INORGANIC CHEMICALS

Fundamental Research Conference

A Joint Conference of the Fundamental Research Committees of the Technical Section, C.P.P.A., and of TAPPI, will be held in Quebec, P. Q. on May 29, 30, and 31, 1950.

The general theme of the Conference will be the "Effect of Fiber Characteristics on Paper and Papermaking Properties." Each of the detailed properties of pulp fibers, individually and in relation to one another, will be systematically discussed in relation to the properties of paper. Critical and interpretive review of the present status of our knowledge of each of these phases of the subject will be presented, and specific gaps in such knowledge will be emphasized for further research.

The program has been divided into a number of individual sessions as follows:

A. (1) *Fiber Dimensions and Physical Structure*—including size, shape, and area of fibers, orientation of fine structures of the fiber, degree of crystallinity of fibers, distribution of crystalline cellulose in the fiber, and molecular weight considerations.

(2) *Strength or Mechanical Properties*—including tensile strength, flexibility, stress-strain relationships, and the effect of moisture on these properties.

(3) *Surface Properties and Measurements*—including measurement of surface area, dry and wet, electrokinetic characteristics, and submicroscopic surface effects.

B. *Interfiber Properties.* (1) *Fiber-water Relationships*—including principles of polymer swelling, swelling of fibers and its relationship to other properties, hygroexpansivity, effect of drying on fibers, bound water and hydration, flocculation, and formation.

(2) *Fiber-fiber Bonding*—including measurement of bond strength and bonding area, nature of the bond, alteration of the bond during water removal, and the effect of additives on wet and dry strengths from a fundamental standpoint.

C. *The Effect of Chemical Composition on the Fibers*—including effects on preparation of the fibers for papermaking and on resultant paper.

Ample time will be allowed for comprehensive discussions of the various phases of the subject at all the sessions, and it is emphasized that the fundamental fiber properties involved will be discussed in direct relation to paper wherever possible. It is expected therefore that this Conference will be of interest not only to research personnel but also to technical men in the industry generally.

Further announcements of speakers, discussion leaders and details of program will be announced shortly. Several distinguished authorities in the field have been invited to take part. The Conference will be held at the Chateau Frontenac Hotel, Quebec City, P. Q., and requests for hotel accommodation should be directed to George Jessop, Manager, Chateau Frontenac. In making reservations, the date and time of arrival and departure should be stated, and those attending are reminded that the Summer Meeting of the Technical Section will be held on May 31, June 1 and 2, at the same place, so that attendance at both meetings is facilitated.

Testing Conference

The first conference of the Testing Division of the Technical Association was held at Pittsburgh, Pa. in 1948. It was unusually successful in its objective.

The 1950 conference is being planned along similar lines. It is to be a work meeting during which the committees of the Testing Division will meet separately for the purpose of resolving some of the problems involved in preparing TAPPI Standards.

The conference will be held at the plant of the Eastman Kodak Co., in Rochester, N. Y., and half a day will be devoted during the conference to a visit to the paper mill and coating plant of the Company. The Technical Association is indebted to Milton Fillius and the officers of the Eastman Kodak Co. for this rare privilege.

Arrangements have been made with the Seneca Hotel, Rochester, N. Y. to provide housing for members of the Association and others who may attend. Room reservations should be made right away. The period of the Conference will be Sept. 13-15, 1950.

This conference differs from the other meetings held by the Association in that few, if any, papers will be presented. The major part of the program will be devoted to round-table discussions of testing methods in process of being developed. Many of these are controversial in nature and require the consideration of available data before the tentative standards can be written.

Any member of the Technical Association is welcome to attend. The chairman of the Testing Division committees are as follows:

General Chairman—James d'A Clark, Consultant, Longview, Wash.
Fibrous Materials Testing Committee—E. R. Schafer, Forest Products Laboratory, Madison, Wis.
Nonfibrous Materials Testing Committee—J. P. Casey, New York State College of Forestry, Syracuse, N. Y.
Wax Testing Committee—A. M. Heald, Marathon Corp., Menasha, Wis.
Pulp Testing Committee—L. V. Forman, Institute of Paper Chemistry, Appleton, Wis.
Optical Properties Committee—A. H. Croup, Hammermill Paper Co., Erie, Pa.
Microscopy Committee—C. E. Brandon, Aetna Paper Div., Howard Paper Mills, Dayton, Ohio
Paper Testing Committee—A. K. Warner, Skinner & Sherman Inc., 246 Stuart St., Boston, Mass.
Container Testing Committee—W. J. Balster, Don L. Quinn Laboratories, Chicago, Ill.
Packaging Materials Testing Committee—L. E. Simerl, Marathon Corp., Menasha, Wis.
Chemical Methods Committee—Milton Fillius, Eastman Kodak Co., Rochester, N. Y.

There are several committees not included in the Testing Division that are engaged in the development of testing methods that may wish to meet during this conference. The chairmen of such committees should advise R. G. Macdonald, Secretary of the Technical Association of their desire to do so.

Any member of the Association who wishes to propose any new methods or has any criticism to offer relative to any of the present methods included in the TAPPI Standards should notify the Secretary.

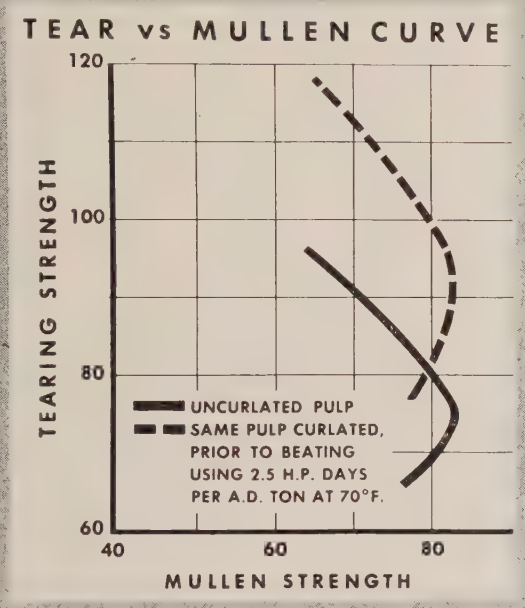
New Subcommittees

At the annual meeting of the Association two new subcommittees were established.

A subcommittee of the Chemical Engineering Committee to be known as The Kraft Digester Corrosion Subcommittee is to be made up of representatives of sulphate pulp mills that are interested in working cooperatively on this important

Curlators Are Proving Their Value

Effect of Curlation prior to beating on the tear-mullen relationship during beating of a previously undried northern unbleached sulphite pulp.



TEST DATA

	HP/DT*	FREENESS	MULLEN	TEAR	DENSO-METER
UNCURLATED PULP	0	840	66.8	93	13
	1	810	77.6	83	34
	2	764	80.8	77	95
	3	672	84.0	75	260
	4	615	81.5	74	580
	5	521	70.8	60	1330
	7	394	66.5	55	3750
	9	285	64.6	54	5660
PREVIOUSLY CURLATED PULP					
	0	836	66.2	117	3
	1	770	82.8	95	22
	2	688	80.2	81	125
	3	575	76.8	72	360
	5	390	71.7	67	2640
	7	270	55.0	48	8280

*H. P. DAYS PER A. D. TON SPENT IN BEATING ONLY.

Note: Tear at maximum mullen of uncurlated pulp is 75, of curlated pulp 95.
Description of testing procedures employed by the Curlator Corporation Laboratory will be provided upon request.

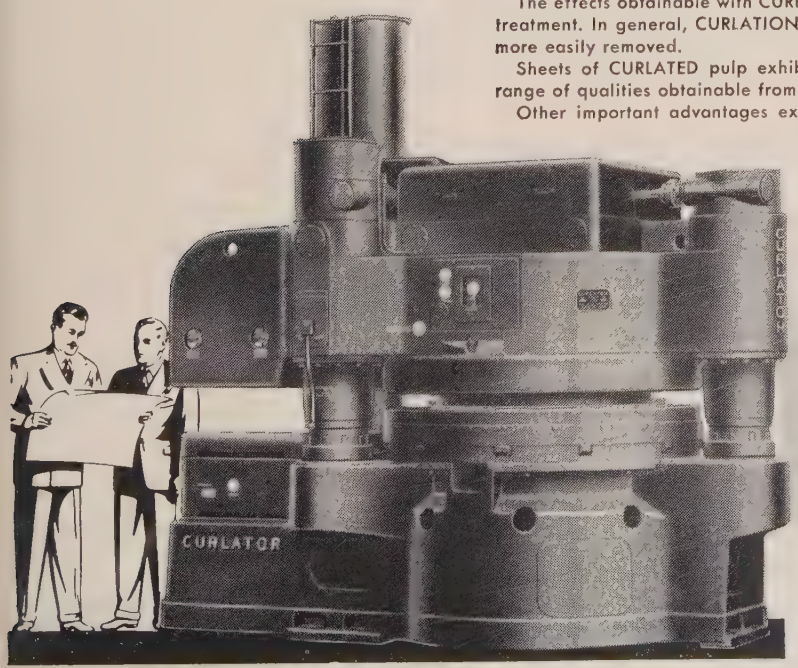
CURLATION is a new mechanical process for improving pulp properties, fully tested and thoroughly proved. Curlation not only produces a permanent change in the shape of pulp fibres, but also exerts a powerful de-shiving action, with negligible change in freeness.

The effects obtainable with CURLATION vary widely with the raw material and the conditions of treatment. In general, CURLATION tends to produce an easier beating pulp from which water is more easily removed.

Sheets of CURLATED pulp exhibit a more even textured matte appearance. In addition, the range of qualities obtainable from a given pulp is broadened.

Other important advantages exist . . . WRITE for new bulletin C-2 on the C-50 CURLATOR.

The CURLATOR is a tool for altering the properties of pulp and paper to obtain qualities hitherto unavailable by mechanical means. The effects of CURLATION vary with the raw material and may be described only in relation to a particular pulp.



CURLATOR†
Corporation
565 BLOSSOM ROAD · ROCHESTER 10, NEW YORK

†T. M. Reg.—Curlator Corporation, Rochester, N. Y.

current problem. J. R. Lientz of the Union Bag & Paper Corp., Savannah, Ga., is the Chairman.

A Corrugated Containers Manufacturers Subcommittee of the Containers Committee was established to work on important manufacturing problems. F. D. Long, Container Corp. of America, Chicago, Ill. was appointed Chairman. Membership on the committee is restricted to individuals employed by corrugated container manufacturers.

TAPPI Fibrary

In response to the Association questionnaire more than one hundred companies and laboratories offered several hundred samples of fibrous materials suitable for use in the manufacture of paper.

These responses have been turned over to John Strange of the Institute of Paper Chemistry, Appleton, Wis. who will organize the establishment of the fibrary. Mr. Strange is classifying the responses to the Questionnaire and will make direct requests for samples. Every effort will be made to have this collection as complete as possible. When the fibrary has been established, individuals or companies will be able to obtain samples of fibers, authenticated as to species and history. Announcements will be made when the catalog of samples has been completed.

Report of Joint Textbook Committee

The Editor reports that at the rate of progress now being made with the production of Pulp and Paper Manufacture, Vol. I (old Vol. III), the McGraw-Hill Book Company expects to have it out early in April. The first galley proofs were received by the editor on September 10 and the last were returned to the publisher on December 19. Page proofs began to come in on January 7 and 692 have now been proof read and indexed. This volume will comprise about 1100 pages dealing with the "Manufacture of Wood Pulps." The previous edition is out of print and the new volume is eagerly awaited; orders are piling up.

Volume II, (old Vol. IV), has been completed and delivered to McGraw-Hill Book Company. This volume deals exclusively with "The Preparation of Paper Making Stock." It contains a great deal of new material and many new illustrations. The material in earlier editions on General Mill Equipment is moved to a new Volume IV.

Volume III, (old Vol. V), "The Manufacture of Paper" will contain an outstanding chapter on Paper Machines—a complete rebuilding of the previous text. The chapters on Coating, Finishing, and Testing are also thoroughly overhauled. The chapter on Papermaking Details has been incorporated in the chapter on Beating and Refining in Vol. II.

Volume IV—Auxiliary Mill Equipment—contains revision of this material in the old Vol. IV, with the addition of new chapters on Instrumentation and Conveying Equipment. This volume will constitute an up-to-date text on important phasis of engineering associated with pulp and paper manufacture.

When the series is completed, the North American industry, acting through its international committee for the past thirty-one years, will once more have supplied the papermaking world with a set of standard reference books of unrivaled scope and authority.

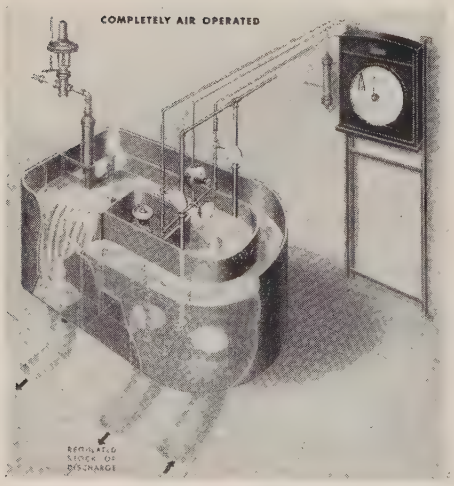
ROYAL S. KELLOGG, *Secretary*

Ed Note: Although no price has been established for the four volumes of *Pulp and Paper Manufacture*, it is expected that Vol. 1 will be $10. Orders may be placed now with the Book Dept., Technical Assoc., Pulp and Paper Industry, 122 E. 42nd St. New York 17 N. Y.

BRAMMER

recording consistency control

For accurate regulation of consistency, and recording both before and after diluting water has been supplied.



Patented and Patents applied for in U.S.A. and Foreign Countries

Manufactured and sold in Canada by Alexander Fleck Limited, Ottawa, Ontario

Regulates the consistency of all types of stocks, slow or free.

Regulates difficult stocks such as rag, dirty waste paper, or free sulphite, and is not affected by the presence of knots, silvers, etc.

A Foxboro instrument and Foxboro Stobilflo diluting water valve do the work efficiently, dependably and maintain consistency regulation to 1/10 of 1%. Many mills report much closer control.

Better control and uniformity are obtained when the Brammer is used before paper machines, washers, Jordans and refiners, knotters, screens thickeners, and before metering and proportioning of pulp.

New Catalog on request.

PAPER and INDUSTRIAL APPLIANCES Incorporated
122 East 42nd Street, New York, N. Y.

Established 1886

"Look beneath the surface; let not the several quality of a thing nor its worth escape thee."
MARCUS AURELIUS

You will find us a most useful resource, whatever your requirements in Bleached and Unbleached Softwood and Hardwood Sulphites, Sulphates, Soda and Groundwood—Domestic or Imported.

Exceptional facilities of international scope and 64 years of intensive association with the Pulp and Paper Industry have equipped us to serve you well.

★

GOTTESMAN & COMPANY
— INCORPORATED —
22 EAST 40th STREET • NEW YORK 16, N. Y.
EUROPEAN OFFICES: Birger Jarlsgatan 8, Stockholm, Sweden

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Maine-New Hampshire

At a get-together of the executive committees of the Maine-New Hampshire and New England Sections during TAPPI Convention week in New York, decision was reached to discuss the theoretical and practical aspects of stock preparation at their joint meeting in June. This session will be held June 23 and 24 at the Hotel Wentworth-by-the-Sea, Portsmouth, N. H. Norman I. Bearse, Champion-International Co., Lawrence, Mass., is chairman of the technical program committee and is arranging for a series of papers to be presented on Friday afternoon on the more theoretical aspects of stock preparation, while on Saturday morning there will be a panel discussion on stock refiners, headed by P. S. Bolton, Robert Gair Co., Uncasville, Conn. Arrangements for the meeting are in charge of J. F. Wright, National Aniline Division, Boston, Mass., assisted by representatives of both Sections.

Empire State

Western New York Groups

The Western New York Group of the Empire State Section held a dinner meeting on Feb. 8, 1950, at the Prospect House in Niagara Falls, N. Y. J. S. Reichert, Chairman, presided. The attendance was approximately 50.

Jack Rudolph, Kimberly-Clark Corp., Niagara Falls, N. Y., announced the program for the remainder of the 1949–1950 season. March 8, dinner meeting with a representative of Time Magazine discussing various aspects of their production and edition of the magazine; April 12, plant trip through Spaulding Fibre Co. mill; and May 10, panel discussion on slime control. He introduced Paul Kuhnel of Kimberly-Clark, as moderator for the panel discussion on felts which followed.

The panel members were Howard Brown, Lockport Felt Co., Irving Peters, F. C. Huyck & Sons Co., Fred Parkinson, H. Waterbury & Sons Co., Larry Woodside, Albany Felt Co. Mr. Parkinson described the processing of wool entering into papermakers' felts from source through sorting, scouring, lubrication, carding, spinning, weaving, joining, finishing, napping, and drying. Mr. Peters discussed the size specifications, requirements, and factors effecting the variations. Mr. Brown explained the purposes of various weaves, their utilization covering a variety of pulps and end paper product finishes. Mr. Woodside pointed out the application elements in felt use which determine its efficiency and life. A general discussion and question period followed covering the growing use of synthetic fibers such as Nylon and eventually Orlon to impart special characteristics and the bactericide preventatives and clean-up methods generally recommended for felts.

From left to right: H. P. Bailey, International Paper Co., Niagara Falls, N. Y.; B. D. Chapman, Time, Inc., New York, N. Y.; Paul Kuhnell, Kimberly-Clark Corp., Niagara Falls, N. Y.; Joseph S. Reichert, DuPont Co. Niagara Falls, N. Y.

The March meeting of the Group took place Wednesday, March 8, at the Prospect House in Niagara Falls, N. Y. Approximately 40 members and guests enjoyed the excellent dinner and meeting presided over by Joseph S. Reichert of the DuPont Co., Niagara Falls, N. Y.

B. J. Staneslow of the Moore Business Forms introduced the guest speaker, B. D. Chapman, Operations Manager for Time, Inc., publishers of Time, Life, Fortune, and Architectural Forum.

Mr. Chapman traced the steps which go into the gathering of news for Time Magazine. Thursday is the important day for Time's readers and for Time's editors as well. This is because Thursday is the date that one issue of Time goes out to its readers and work is started on the next issue. From 11:00 a.m. until late Saturday evening the editors of Time file into the office of the Managing Editor bringing with them the news of the world, gathered from Time Magazine's bureaus in 24 cities, from Time's correspondents in other news-capitals, from the wires of the Associated Press, and from 175 newspapers, 1004 magazines, and scientific, art, religious, and business journals.

In turn each editor outlines the important stories which are building up in his particular field. Whenever a story is considered TIME-worthy its probable length is estimated, pictures suggested, and it is blocked into the dummy for the next issue. When the dummy is filled, the Managing Editor's Office empties. Research goes off on the trail of vital facts. Telegrams and cables are sent to bureaus and correspondents within the cities, and behind closed doors Time's editors begin to cover paper with writing, rewriting, and condensing. This continues for 5 full days and nights until the Monday night deadline.

Now the production department's work begins. Thanks to a marvelous machine called the teletype setter, which enables a man in Time's New York Offices to set type for Time's printers at about 60 words a minute on linotype machines 83 miles away in Philadelphia, another 715 miles away in Chicago and a third 2600 miles away in Los Angeles, then less than 10 hours later complete printed copies of Time are on their way to readers. Mr. Chapman also discussed the preparation of Life Magazine emphasizing the importance of pictures in this magazine. Following his address a question and answer period was held.

Hudson River Valley Group

On March 16 the Hudson River Valley Group of the Empire State Section visited the Wallpaper and Pigments Division of the Imperial Paper & Color Corp. at Glens Falls, N. Y. and also the plant of the Sandy Hill Iron & Brass Works at Hudson Falls, N. Y. At the latter plant a 160-inch fourdrinier was set up on its floor for inspection.

In the evening a dinner meeting was held at the Village Inn, South Glens Falls where Harold Sholl, of the Brown Instrument Co., gave a talk on Pulp and Paper Mill Instrumentation. Several members participated in an instrumentation forum during which mill experiences in instrumentation were cited.

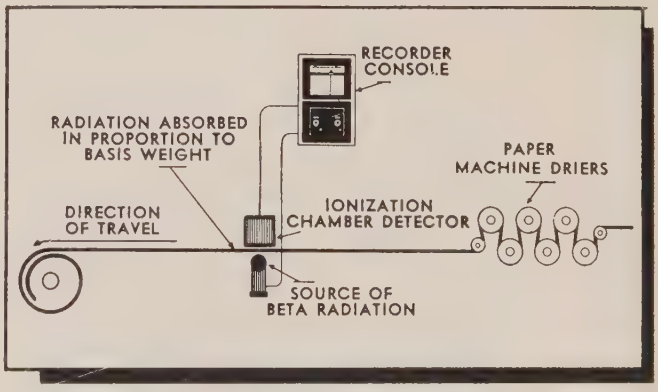
The Tracerlab BETA GAUGE

For CONTINUOUS BASIS WEIGHT CONTROL

SHORTEN STARTUP TIME • IMPROVE QUALITY CONTROL • SAVE PULP STOCK • ELIMINATE OFF-WEIGHT REJECTS • DECREASE VARIATIONS ACROSS SHEET

The Tracerlab Beta Gauge is a completely new and unique instrument for measuring and recording weight per unit area of a wide range of paper and board products directly on the production line. It uses beta radiation from Oak Ridge produced radioisotopes to achieve a high degree of accuracy and sensitivity and is unaffected by variations in chemical composition of the material being measured. This is a non-contacting type of gauge designed for the severe operating conditions usually encountered in production operations. In addition to the recording type, a non-recording industrial model and a laboratory model of the Tracerlab Beta Gauge are also available.

Let us know your gauging problems and we will gladly advise you how the Tracerlab Beta Gauge can help you.



Write for Beta Gauge Bulletin T-20

Tracerlab

Western Division
2295 San Pablo Ave., Berkeley 2, California
New York Office
General Motors Building, 1775 Broadway, New York 19
Midwest Office
LaSalle-Wacker Bldg., 221 N. LaSalle St., Chicago, Ill.

TRACERLAB INC., 130 HIGH STREET, BOSTON 10, MASS.

Chicago

The Chicago Section met at the Chicago Bar Association, Chicago, Ill., on March 30.

L. S. Johnson, Technical Director, Cornell Wood Products Co., Milwaukee, Wis., discussed "Paperboard for Folding Cartons."

W. C. Wilson, Vice-President, Pyroxylin Products, Inc., Chicago, Ill., talked on coatings and heat sealing. In this talk Dr. Wilson discussed the limitations and uses of heat-glazing coatings, new synthetic coatings such as styrenated alkyds, organisol and plastisol coatings, heat-sealing melts and lacquers and possible laminations and combinations of paper with itself and other materials such as foils, cellulose acetates, polyethylene and the like.

Delaware Valley

The Delaware Valley Section met at the Engineers Club, Philadelphia, Pa. on March 23. A. E. Montgomery, J. O. Ross Engineering Corp., Chicago, Ill., talked on "The Drying of Paper on the Paper Machine."

Kalamazoo Valley

The Kalamazoo Valley Section held its March 2 meeting at the Columbia Hotel in Kalamazoo, Mich. There were 70 members present plus 3 student guests from the Western Michigan College Pulp and Paper School. Dr. Kukolich presided over the business meeting which consisted of passing a motion to establish a prize fund for the Western Michigan College Pulp and Paper School.

After the business was transacted, Dr. Kukolich turned the meeting over to J. J. Harrison, who introduced Harold Bialkowsky, Research Director of the Weyerhauser Timber Co., Pulp Division, Longview, Wash. Dr. Bialkowsky spoke on "Recent Developments in Pulping and Their Effects on the Converter." Dr. Bialkowsky said, in part:

"There are three prevalent species of wood in the West Coast area, hemlock, Douglas fir, and red cedar. Hemlock is usable as a pulp wood in the sulphite pulping process. Douglas fir is a good lumber wood and can be pulped only by the kraft process.

"The greatest progress and development on the West Coast in the past ten years has been done in the timber areas. A continuous supply of wood for perpetual operations is now established. Prelogging and relogging have contributed to increased supplies of pulp wood.

"Prelogging consists of thinning the forests from a tree population of 800 to 1000 per acre to about 200 per acre. With 200 trees per acre, the land is able to promote healthier and more rapid growth. Prelogging gives some pulpwood, Christmas trees, etc.

"Relogging consists of going back over land that has been logged and picking up the trees which were left as too small at the original logging operation. The best method of reseeding seems to be to leave a certain number of trees behind to seed naturally. This method outshines hand and machine seeding. After a few years prelogging and relogging takes place. The most difficult problem is protecting the forests from fires, most of which result from cigarette butts.

"Greatly improved barking operations have resulted in a reduction of from 1150 to 750 feet per ton of pulp. Contributing to this improvement are the uses of hydraulic barkers and debarking at the lumbering operations before sawing. The slabs from sawmills can then be sent to the kraft operation in a condition ready to pulp.

"There have been no great advances in the actual pulping operations in the last few years.

"Much attention is paid to the uniformity of operations in the pulping process. Chip size is controlled, weight of chips to the digesters is controlled to the nearest $^1/_{10}$ ton, the concentration of the acid is very carefully controlled, and the quantity used is carefully measured. A very definite temperature cycle is followed, and the temperature rise is carefully controlled. The cooks must blow within five minutes of the specified time.

"The conditions of the cooks are changed for different grades. The conditions in a sulphate cook are equally as well controlled.

"The sulphite bleaching process consists chiefly of cook, direct chlorination, caustic extraction, wash, hypochlorite bleach, wash, screening and drying.

"The sulphate bleaching process consists of cook, direct chlorination, wash, direct chlorination, caustic extraction, wash, hypochlorite, wash, hypochlorite. A second sequence might be cook, direct chlorination, wash, hypochlorite, caustic extraction, wash, hypochlorite, wash, hypochlorite.

"The chlorination stage is carried on a pH of 1.5–2.0 where the chlorine exists as elemental chlorine rather than hypochlorous acid and the hypochlorite stage is carried on at a pH of 8.0 to 9.0 where hypochlorous acid is nonexistent. The elimination of hypochlorous acid prevents direct oxidation of cellulose to preserve strength and helps shrinkage.

"During the discussion period the recent development of the New York State College of Forestry on the use of hard woods was discussed. It was explained that the purpose of this work was to utilize the hardwoods, (beech, birch, etc.), which have replaced the previously logged conifers, as pulp and then to reseed with coniferous varieties. The pulp will be a semi-chemical pulp. Semichemical pulps result in higher yields and produce a stiffer sheet. The lignin content is higher than a chemical pulp and the chlorine and hypochlorite demands in bleaching are higher.

"Another point of discussion was the use of chlorine dioxide and sodium chlorite as bleaching agents. These agents are expensive but might be used if an extra two or three points brightness over normal were desired. The use of oxalic acid as a bleaching agent fits into this same category."

J. R. Dan, *Secretary*

Ohio

Pulp Testing Procedures was the topic of the panel discussion of the March 14 meeting of the Ohio Section of TAPPI held at the Manchester Hotel, Middletown, Ohio. After a short business meeting with Chairman Arthur Thurn presiding, the panel was introduced by M. G. Lyon of Champion Paper & Fibre Co. The panel consisted of C. E. Brandon, Aetna Paper Co., Moderator; Howard Laymon, Mead Corp.; E. F. Parmenter, Champion Paper and Fibre Co., and Don Goodman, Sorg Paper Co.

Pulp strength testing was discussed by Mr. Laymon, who inquired, "What do we mean by the strength of pulp? Is it the strength of the individual fiber, felting strength, blending strength, unrefined or refined strength, if refined how much and the type of strength—mullen, tear, or tensile." From a papermaking standpoint we are more interested in the felting strength of pulp. If one is buying pulp the question is, what is it worth to him? It is possible that a pulp that increases in strength rapidly and falls off quickly may serve a purpose better than a pulp whose strength rises slowly and reaches a high test. The TAPPI methods of physical testing of pulp have their limitations and produce data that must be interpreted in each mill in accordance with its local practices. Mr. Laymon concluded his talk by discussing various types of laboratory refining equipment and methods of making handsheets.

E. F. Parmenter in his discussion on chemical tests on pulp pointed out that these tests were of somewhat limited practical value in the prediction of papermaking qualities.

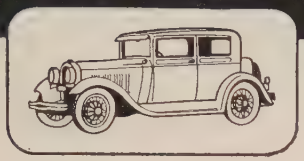
"It should be recognized that the chemical characteristics of pulp always have been of interest primarily to the manufacturers and consumers of dissolving pulps rather than papermaking pulps. From time to time attempts have been made to correlate chemical tests with various papermaking characteristics, with moderate success in some instances.

"For the purposes of this discussion, let us consider wood pulp, not as a mass of tangled fibers, but rather as a simple chemical mixture composed largely of groups of carbohydrates of greatly varying molecular size. Associated with this carbohydrate material is a relatively small quantity of mineral matter. In the case of an unbleached pulp, a certain amount of lignin is also present.

"If the ash contains a high proportion of calcium carbonate originating from lime bleaching or from a high-lime content process water during pulp manufacture, the ash becomes important from the standpoint of papermaking. Under such conditions the ash content of the pulp will be reflected in the

There's been some changes made!

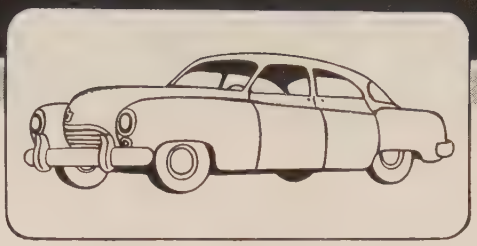
IN CARS . . . AND IN NORTON PULPSTONES



1926

IN 1926 Norton introduced to the paper industry the *first* manufactured pulpstone. It was made only in CRYSTOLON abrasive, in one structure and in a very limited number of grain sizes. Its use was confined largely to producing newsprint pulp in grinders with a power input of about 400 H. P.

But the paper industry was quick to take advantage of the new tool that Norton had developed for it.



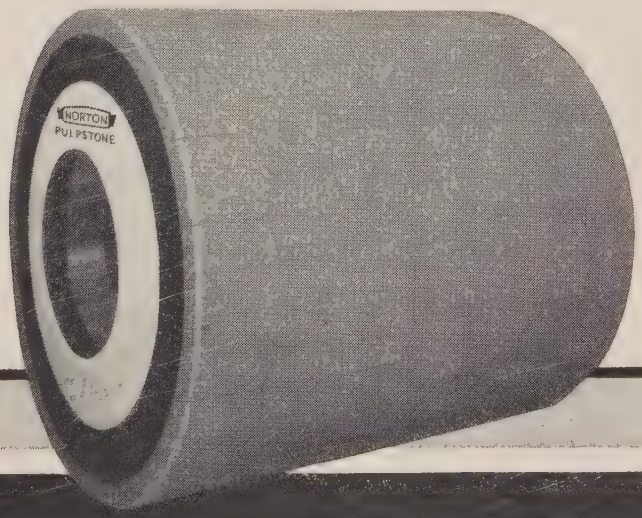
1950

CLOSE co-operation between Norton technicians and those of the paper industry led to rapid and continual improvements in the Norton Pulpstone and thereby expanded opportunities for its application.

Today the Norton Pulpstone is operating in grinders with a power input in excess of 3500 H. P. Its several abrasives, range of structures and variety of grit sizes make possible an infinite number of combinations. Thus from many kinds of wood it is producing the types of pulp required not only for newsprint but also for magazine paper, insulating board, molded paper products, hanging papers and countless others.

Yes, the paper industry was quick to take advantage of the new tool which Norton originated and introduced to it 24 years ago.

It's easy to tell at a glance the vast improvement that has been made in the automobile between 1926 and 1950. Visually the difference between the original Norton Pulpstone of twenty-four years ago and the Norton stone today is not so apparent but its technological improvement has been tremendous.



NORTON ABRASIVES

"Making better products to make other products better"

NORTON COMPANY, WORCESTER, MASS. • NORTON COMPANY OF CANADA, LTD., HAMILTON, ONT.

Group attending TAPPI Ohio Section and Superintendants joint meeting, Middletown, Ohio, Feb. 9, 1950

relative amount of size and alum required to properly size the resulting paper.

"In the case of unbleached pulps, there is a rough relationship between the lignin content and pulp strength. As the lignin content of extremely raw pulps decreases there is an accompanying increase in strength properties up to a maximum corresponding to a lignin content of about 7–11%. Further decrease in the lignin content below this general level is accompanied by progressive reduction in pulp strength. In the case of relatively soft unbleached pulps which are to be subsequently bleached in the paper mill, the lignin content is again of interest, for this governs the amount of available chlorine required to bleach the pulp.

"Custom has led us to think of carbohydrates in pulp as divided more or less sharply into three types of cellulose; alpha, beta, and gamma cellulose. It is emphasized that these are very arbitrary divisions, based on the solubility behavior of bleached pulp in caustic soda of mercerizing strength at room temperature. Alpha-cellulose is defined as that portion of the pulp which is not dissolved by 17.5% caustic soda under certain specified and controlled conditions. The soluble portion can be further subdivided into beta-cellulose, that portion which can be precipitated by acidification; and gamma-cellulose, which remains soluble after acidification. Pulps which contain a high proportion of alpha-cellulose are usually more resistant to hydration, and the resulting paper is frequently of greater permanence. Otherwise, the alpha-cellulose content of a pulp is of little significance from a papermaking standpoint.

"Papermaking strength and ease of hydration are said to be related to the hemicellulose content of the pulp. There are no simple chemical tests by which we can easily analyze a pulp for its content of specific hemicelluloses, although numerous empirical methods are available which are indicative of the hemicellulose content.

"Usually, pulps possessing high-pentosan content exhibit high strength and easy-beating characteristics. Mitscherlich pulp contains a higher proportion of pentosans than a conventional sulphite pulp. In fact there seems to be a general relationship between pulp strength and hemicellulose content, regardless of whether the latter is estimated by pentosan content, gamma-cellulose, or soda solubility. The pulp degradation products, oxy- and hydrocellulose, are also capable of increasing the ease of hydration, but usually cause a reduction in pulp strength.

"Viscosity is another pulp test which may be of value from a papermaking standpoint. The viscosity value obtained in centipoises can be considered a measure of the average chain length of the cellulose molecule. The visocisty test is an excellent guide in evaluating the degree of pulp degradation occurring during the various stages of pulp processing.

"It should be emphasized that the viscosity test is of absolutely no value whatever in predicting the papermaking properties of two unrelated pulps. In addition to fiber length and other physical properties, pulp strength characteristics are dependent upon the hemicellulose content, as well as on the average chain length of the cellulose molecule. For example, the viscosity of a short-fiber hardwood soda pulp might be considerably greater than that of a bleached pine kraft, but common sense tells us that the pine kraft would show considerably greater strength properties.

"While of value, principally as a control during various phases of pulp manufacture, it seems likely that viscosity determinations could prove helpful in grading purchased pulps, if used with caution with respect to the limitations involved. For example, it seems quite possible that a fairly direct relationship might be found between the viscosity values of several shipments of a given grade of pulp obtained from the same pulp manufacturer, and the relative strength characteristics of these shipments."

Don Goodman of Sorg Paper Co. enumerated several tests for pulp examination or inspection in addition to physical or chemical testing. These include:

1. Spectral Reflectance and Color of Pulp: TAPPI Standard T 216 m-47 describes a method of measuring the spectral reflectivity of pulp, usually expressed in the form of a curve giving reflectivity as a function of wavelength over a range of 400–700 millimicrons. I doubt if many buyers of pulp believe that the information derived merits the work and expense involved. We are more interested in the uniformity of color from bale to bale. This can be easily and quickly determined by visual examination of the samples obtained during the sampling of the car of pulp.

2. Brightness: The term brightness has come to be associated with the numerical value of the reflectance of pulp or paper to light in the blue or violet portion of the spectrum. If the brightness test on an incoming car of pulp does not check exactly the results indicated by the supplier, do not be too surprised. A number of factors can account for this apparent discrepancy. These include: (*A*) Pulp degradation. (*B*) Errors in test due to (*a*) sampling of car, (*b*) too much dilution in making the handsheet, and (*c*) contamination of the sample in making the handsheet. (*C*) The pulp company may be checking brightness before drying on the pulp machine. This would tend to give a higher value than if checked after the pulp is dried.

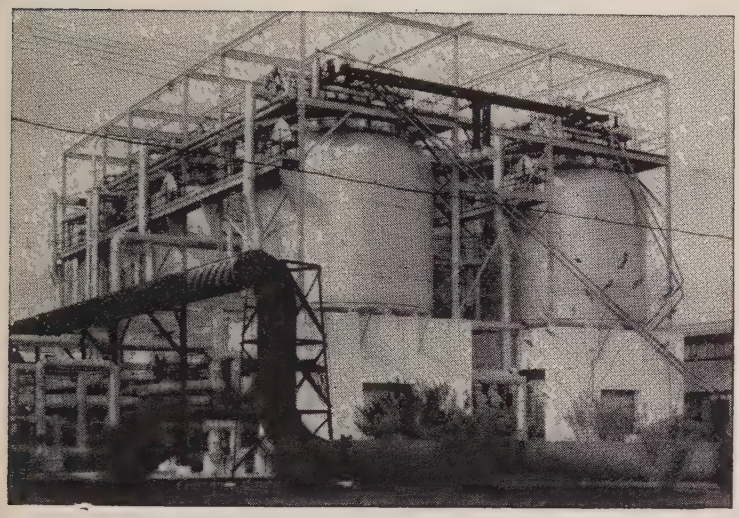
3. Dirt in Pulp: Over the years a number of methods for the determination of dirt in pulp have been advanced, all of which have their advantages and disadvantages. TAPPI Standard T 213 m-43 is one method now being used. In this method, pulp sheets totaling 2000 sq. cm. areas are observed and the dirt specks compared to a standard comparison chart. It has the advantage of giving a numerical value which is relatively reproducible but also has the following limitations:

SULPHUR

*Interesting Facts Concerning This Basic Raw Material from the Gulf Coast Region

*SUPERHEATED WATER . . .

Mining operations are most successfully carried out if the water pumped into the sulphur deposit is heated under pressure to a temperature of about 320° F. For large scale mining, enormous quantities of water are required, so, a primary requisite is an adequate supply of suitable water and an efficient power plant in which to heat it.



To insure a continuous supply of water at Newgulf, it is the practice to use river water pumped in time of flood or full flow and stored in large reservoirs. This supply is supplemented, when necessary, with well water. Water so obtained is seldom suitable for use in boilers or mine water heaters without being treated first because of natural salts in solution. Softening by chemical treatment is necessary to prevent deposition of scale on boiler tubes and hot water lines.

Loading operations at one of the huge vats of Sulphur at our Newgulf, Texas mine. Such mountains of Sulphur are constantly being built at our mines, from which shipments are continually made.

TEXAS GULF SULPHUR CO.
INC.

75 East 45th St. New York 17, N. Y.

Mines: Newgulf and Moss Bluff, Texas

(*A*) Area only is used with no allowance for different weight pulp sheets. (*B*) Surface dirt only is counted. (*C*) No allowance for different surfaces such as obtained by a Kamyr press and which makes an apparent difference in the visibility of the dirt.

Another fairly simple method is to wet a sheet of pulp and place it over a frosted-glass plate illuminated from below. A comparison chart similar to the one used in the TAPPI standard can be used or the dirt specks arbitrarily classified as large, medium, or small. This method also has the disadvantage of permitting no allowance for the weight of the sheet tested.

4. Fiber Classification: The purpose of fiber classification is to segregate mechanically a given fibrous sample into a number of separate groups of fibers differing in range of fiber length, such segregation to depend solely on fiber length and to be independent of origin, treatment, preparation, width or other factors, and to determine the proportion, by weight, of fiber in each length group so obtained. The results of the fiber classification can give us a yardstick to compare the way various pulps have responded to our beating or refining operations. Some mills have been fairly successful in tieing in these results with the machine performance and such physical tests as mullen, tensile, tear, etc.

5. Microscopic Examination of Pulp: By an examination of the pulp with the microscope it is possible to identify the species of fiber used in making the pulp. It is also possible to measure the fiber length with the microscope.

During the question-and-answer period which followed there was considerable discussion in regards to the disk refiner used by Mead Corporation for strength testing. This unit is a small disk refiner with the pressure being controlled by a weighted lever on the stationary plate. This gives a one-time unit of refining instead of a full curve. The charge consists of 80 grams o.d. pulp at 2% consistency. The rotating disk acts as a pump to bring the stock in at the center and out at the edge. The time elapse is 20 seconds but this can be changed to suit individual conditions. For this time of treatment a sulphite pulp with an initial freeness of 700 cc. will be reduced to about 570 cc. In 80 seconds' treatment the freeness would be lowered to about 200 cc. The speed of the rotating disk is 325–340 r.p.m. Accurate results are obtained as the freeness of duplicate tests seldom varies more than 10 cc.

After the question-and-answer session a motion picture was shown, "Trees to Tribune," which covered the operations of logging, paper manufacture, and shipping and handling the finished paper for the Chicago *Tribune*.

E. O. Knapp, *Recording Secretary*

LETTERS TO THE EDITOR

Chipper Drives

To the Editor, *Tappi*

I want to ask a few questions with regard to an article by William Staniar on p. 67 A, etc. in the January, 1950 issue of *Tappi*.

1. Why doesn't Mr. Staniar like direct coupling of motors to chippers? I have recommended direct coupling to 10-knife Ottersland chippers in many instances. One is running with 750 and another with 600 r.p.m., both satisfactorily. The arrangement saves space and diminishes the energy consumption, because the belt losses are avoided. The main shock is taken by the disk and the fly wheel, and the shock on the motor is very small.

2. Is he quite sure that the rubber belt causes greater losses than a leather belt? The losses are caused not only by the slip but also by friction inside the belts, and so is the apparent slip.

3. Is it not possible to use a belt tension device for both kinds of belts?

4. The V-belts might stand the shocks, but I do not like them for other reasons. The efficiency of such belts cannot be very high. For a chipper drive it is necessary to provide the power transmission for the maximum torque of the motor, i.e., for 2 or 25 times the normal torque. For a fair size motor, say 300 hp. the belts must stand 700 hp. This makes a rather clumsy drive. A considerable belt speed is not allowed. Hence, the inertia of the pulley is not sufficient, and an additional fly wheel is required, which makes the drive still more clumsy. Does Mr. Staniar agree?

I wish to add that we, here in Sweden, like to direct couple whenever we possibly can, not only because of the saving of space and power but also because of the difficulty of getting a decent belt during a war. When a speed reduction is necessary, I see no objection to the use of gears for large motors if properly dimensioned, also for chippers.

Torsten Samson,
Stockholm, Sweden

Sodium Silicates in the Paper Industry

To the Editor *Tappi:*

Our attention has been drawn to the article "Sodium Silicates in the Paper Industry," (*Tappi*, 32, No. 11, Nov. 1949, 520–528). On page 527, second column, the following sentences are quoted:

"A silicate cement long used in lining sulphite digesters consists of 2 parts of 20-mesh ground quartz, 1 part Portland cement and sufficient 52°, 2.4 ratio silicate to give a good working consistency. This is mixed in small batches since it sets almost immediately. Between the two brick linings is put a packing of similar cement, with 4 parts of quartz to 1 of cement.

"Probably, a silicate cement as described has never been used in any sulphite digester anywhere in the world. A similar cement made from a carefully graded quartz sand and 42° Be. sodium silicate was used in North America about twenty-five years ago in a few digester linings. It was never used extensively. Slight modification of the same cement has been used in a number of Scandinavian installations. A mixture of 4 parts of quartz to 1 part of cement would never be used by anyone understanding sulphite digester lining requirements."

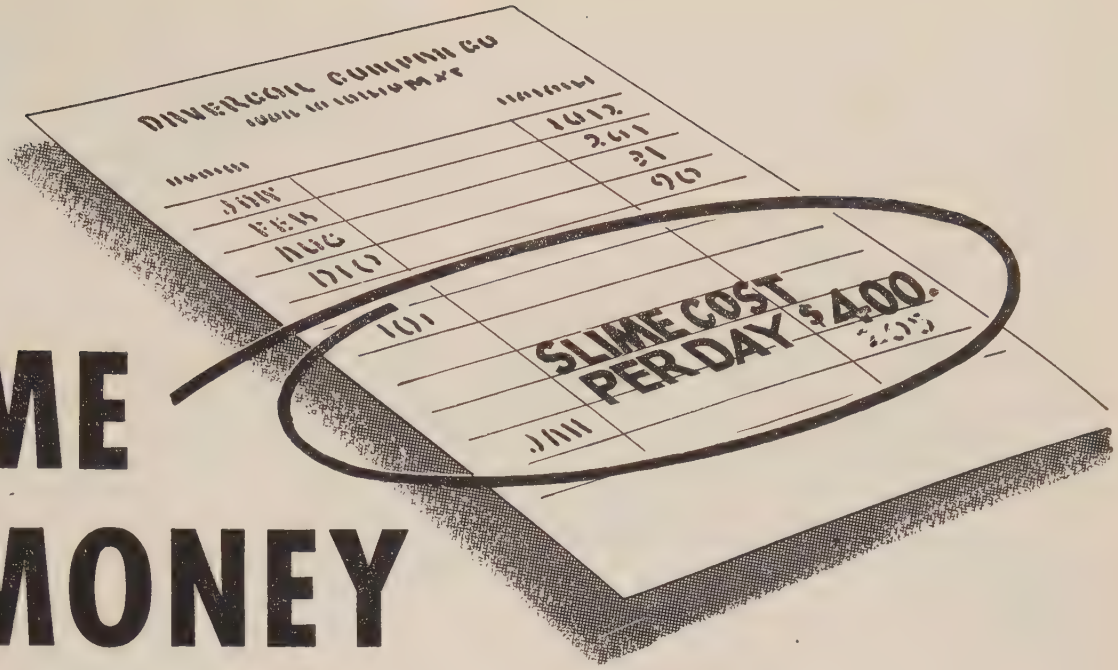
E. F. Tucker, Vice-President
Stebbins Eng. & Mfg. Co., Watertown, N. Y.

Economic Fellowships

To the Editor *Tappi:*

Through the cooperation of The Institute of Paper Chemistry, the Foundation for Economic Education, and a business firm, the author was awarded a fellowship this past summer to study the economic functioning of a large corporation. Because the doors of the Northwestern Mutual Life Insurance Company in Milwaukee were so hospitably and generously opened to me for six weeks, I feel strongly the worth of the College-Business-Exchange Program launched in 1948 by the Foundation, and wish to report on it to the paper industry.

The Program this last summer was supported by twenty manufacturing companies, banks, and insurance companies.

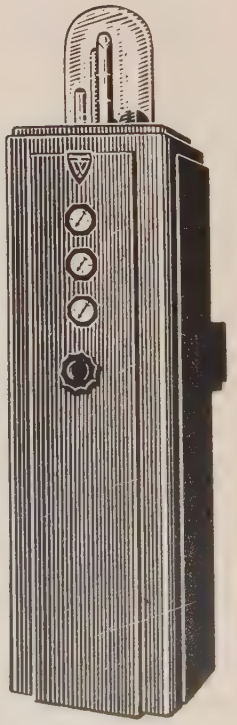


SLIME IS MONEY

Although you may never see a bill, studies show that slime costs the average paper mill $400 or more a day and is responsible for such costly troubles as wet end breaks, pin holes, slime spots, poor sheet formation, etc.

Break-Point Chlorination, engineered to your particular needs, has proven its slime fighting ability in hundreds of installations. This process, applied by dependable W&T Chlorinators, to your fresh water supply, often in conjunction with chloramines or other corrective chemicals to your stock or white water, gets results because it destroys the very cause of the trouble — slime forming bacteria. Moreover, members of W&T's nation-wide service organization with over 35 years' experience at their fingertips, carefully engineer each installation, to insure that you will receive maximum protection against slime at the lowest possible cost.

Your nearest W&T Representative will be glad to give you full details on how Break-Point Chlorination can cut your slime costs. Call him today.



WALLACE & TIERNAN
COMPANY, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
NEWARK 1, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES

I-28

Among the list of supporters was one from the paperboard industry, the U. S. Gypsum Company. Fellowships were given to thirty teachers of economics from twenty-seven educational institutions. The awards allowed them the opportunity to learn about the business world in order that they could more accurately represent it in the classroom.

The Program states:

"Fellowships are offered to economics teachers and research workers in colleges, covering a period of six weeks' study of a business firm during the summer . . . . The program is not a plan to train economists for business. Nor is it the purpose of the program to entice college teachers away from their academic profession, but rather to offer them an opportunity to become more proficient and effective in their work . . . .

Recipients of such fellowships in the past have looked on them as a means of education, rather than employment . . . . The business firms undertaking the program are asked to permit completely free and open inquiry, and observation of all phases of its operations by the Fellow. The fellows, on the other hand, are expected to approach their study with a spirit of inquiry and a research attitude."

Because I believe many paper companies may be interested in cooperating with the program another year, this report is written. The first question which comes to mind is what does the paper industry have to gain by granting fellowships to teachers of economics? The industry, being dependent upon trained men, is interested in the type of training available for them. To the extent that teachers of economics fail to understand and to represent truly the business and industrial world as it actually functions, to that extent the training for leadership positions in industry is greatly impaired.

The paper industry has granted fellowships for the training of students especially for its own use, either at a university or in the industry's own school, The Institute of Paper Chemistry. A study of the industry's fellowships shows that precedents have been set for supporting the training of industry leaders in general. Many a fellowship given does not benefit directly the company giving it and this would be true of the new type of fellowship. Last year the participating firms paid the fellows' transportation and living expenses for the six-weeks' period. But the most significant expense is in the time given to the fellows by busy executives and other personnel. How can such expenses be justified? The companies participating in the program must be aware of the fact that the fellowships will probably not reward them financially. They are a public relations expense of long term nature and can be justified only on that basis.

Industry generally, and many paper executives in particular, are interested in, and alarmed by, the growing separation of economics as taught in colleges today and as practiced by business and industry. This separation has led to a misunderstanding of the business world among some teachers of economics which might not be true if they had some way of relating their theories to the functioning of the actual economy.

Some teachers of economics have had enough practical experience in business or industry to realize its importance and, consequently, have required "practicums" for their students. But not many. One reason may be that there have been few opportunities to study the complete functioning of a corporate entity. Some economists have worked in industry with the hope of understanding it, only to be denied the opportunity to observe the functions of enterprise and the making of important decisions which distinguish our system from authoritarian ones. Therefore, some have come away with antagonism and misunderstanding as to the uniqueness of a privately run corporation. It is the importance of the role of the enterpriser that some theoretical economists and the general public are apt to miss. It is here that socialist and present-day liberal thinking is the most fanciful and it is here that private industry leaders can best do a public relations job.

Within recent years the influence of economists in government and in education has increased considerably in molding public opinion. By reaching the ear of government administrators, economists who have not had the opportunity of understanding the functioning of a free economy have aided in the present antagonisms which have placed business and industry leaders in a derogatory light. A summer's study in a company could, if handled right, allow teachers of economics the opportunity of understanding the important role of the enterpriser in our economy. It could force them to question the importance of a number of economic theories presently taught and to wonder about glaring omissions in current economic textbooks. It might show the importance of production which recently has been almost forgotten in the emphasis on the distribution of wealth and income. Moreover, six weeks of study of a corporation would enliven the lectures of many an economics teacher by providing illustrations from the economic world as it is functioning currently. Student interest is considerably increased by the use of illustrative material.

As a recipient of one of the fellowships this summer, I was conscious of the tremendous role of those in executive positions in making decisions affecting wide areas of our economy and I was conscious also of the dignity and loyalty of employees when guided by an intelligent personnel administration. In addition, I saw clearly the role played by life insurance companies in today's economy, not only by aiding the individual to be responsible in the capitalizing of his income for the future protection of those dependent on it, but also by providing one of the chief sources of long-term capital needed for industrial growth. In the recent postwar period, the paper industry has depended heavily on life insurance companies for outside funds with which to expand.*

Although a company cooperating in the program may realize no immediate financial gain from having teachers of economics in there companies for six weeks, other gains may be expected. The plan could stimulate industrial leaders to probe some of their methods, motives, and purposes and to analyze why the public fails to appreciate their importance.

If the fellowship program is not handled correctly, it could be a complete waste of time and money for both the company giving the fellowship and for the teacher of economics holding it. The poor public relations job of industrial leaders in the past is shown in the prevailing attitudes of college teachers and many others who have not come in direct contact with the role of the enterprising factor in our economy.

In the tremendous public relations job that needs to be done if the public is to learn enough about business and industry to appreciate a free economy as opposed to authoritarian schemes now being so widely proposed, the College-Business-Exchange Program has an important part. Moreover, if industrial management does not take the leadership in that movement, the job will not get done.

Because the paper industry is a major one in the national economy and represents competition in its various aspects, it is worthy of much analytical study by economists. Paper executives may wish to cooperate with the fellowship program of giving teachers of economics the opportunity of testing their theories by observing the economic functioning of their corporations. The program, to be effective, would have to be approved and supported by top management. To understand the actual day-to-day decisions of top management, as well as the importance of all other personnel, in a real live corporation is the best means of getting teachers of economics to be articulate enough on the enterprise system to pass that understanding on to their students. Paper executives have the opportunity of co-operating with the College-Business-Exchange Program through the Foundation for Economic Education, Irvington-on-Hudson, New York.

Ruth E. Shallcross, *Research Associate*
Institute of Paper Chemistry, Appleton, Wis.

* A study is currently under way on the role life insurance companies have played in financing the postwar expansion of the paper industry.

Soya Products Division of Glidden, Chicago—America's vast center of soybean research and processing often referred to as Soybean City.

From SOYBEAN CITY...

Quality Soya Proteins for the Paper Industry

Glidden ALPHA* PROTEIN

Glidden PROSEIN*

Coating papers with this chemically isolated, soya protein adhesive definitely *adds* to their quality. Paper coaters everywhere have learned from experience that it introduces efficiencies which actually lower coating costs! Here are just a few of the unusual properties of Glidden Alpha* Protein which it will pay *you* to know about:

- Glidden Alpha* Protein solution is stable over a wide temperature range.
- Glidden Alpha* Protein is compatible with the various pigments used and binds them to the fiber of the raw stock easily.
- Glidden Alpha* Protein adhesive has a color which does not affect, to any extent, the colors of the pigments used or their hiding power.
- Glidden Alpha* Protein alkaline-cut adhesive permits addition of formaldehyde to coating colors to make the finished paper water resistant.
- Glidden Alpha* Protein adhesive is free-flowing at a low water ratio.
- Glidden Alpha* Protein adhesive keeps pigments or other insolubles more uniformly suspended—prevents formation of hard, difficult-to-disperse masses.
- Glidden Alpha* Protein adhesive sets quite rapidly and dries easily without undue shrinkage or interference with the finish when the paper is calendered.

A mechanically refined soya protein adhesive, Prosein* is preferred for reasons of economy in cases where certain outstanding qualities exclusive to Alpha* Protein are not required. Compatible with Alpha* Protein and other alkaline-cut protein adhesives in all proportions. An efficient adhesive for many uses.

★ ★ ★

In its completely equipped Service Laboratory, staffed by experts on all phases of paper processing, Glidden will test the use of its soya protein materials using *your* type of paper according to whatever procedure *you* specify. On the results of such testing, we feel confident you will want to join the steadily growing number of paper coaters using Glidden soya protein adhesives exclusively.

*Trade Mark Registered

The Glidden Company
SOYA PRODUCTS DIVISION
5165 West Moffat Street, Chicago 39, Illinois

QUALITY Glidden PRODUCTS

REPORTS AND DISCUSSIONS

Presented at National and Regional Conferences

Standardization of Spherical Bearings

The session of the Engineering Research and Machine Design Committee was opened by Philip H. Goldsmith, Pusey &. Jones Corp., Wilmington, Del., *Chairman* who introduced George H. Spencer of the Torrington Co., Torrington, Conn. Mr. Spencer presented a paper on "Suggested Standardization of the Spherical Bearings on the Wet End and Drier Sections of Paper Machines." This paper, presented at the Fourth Engineering Conference of the Pulp and Paper Industry, Boston, Mass. on Oct. 31, 1949, appeared in the October, 1949 issue of *Tappi* (32, No. 10: 433–439).

Following the presentation of Mr. Spencer's paper, C. W. Ziegenbusch, Mead Corp., Chillicothe, Ohio read the comments of William G. Gray, Jr., Plant Engineer, St. Marys Kraft Corp., St. Marys, Ga.

"The history given on the development of the bearings and reasons for the betterment of design and application should be useful to one and all. Most certainly the types now employed with the principles involved and specific manner of application, coupled with the advantages and disadvantages, prove an excellent basis for what follows.

"When Mr. Spencer moves into the section discussing "Bearing Protection, Lubrication and Maintenance," the undersigned often wishes more would be done to insure the exclusion of water from wet-end spherical roller bearings as we seem to find that various greases supplied by major manufacturers, although processed for application where water contamination is to be expected, do not have characteristics that make for long-bearing life. Very possibly the undersigned's contemporaries may not agree but this is based on observations in this plant and in others with similar machinery.

"In considering the predicted life of spherical roller bearings and having paid close attention to Mr. Spencer in the past, there still arises the question as to the effect of temperature on bearings employed on the dry end, or drier section, of paper machines. This may hinge on the lubricants used and the tremendous changes in temperatures due to shutdowns, etc. From positive experience on our machine, bearings apparently loaded and running at exact or similar speeds on the wet end enjoy much longer life than those on the dry end. This presumes that water has not entered and adversely affected the bearings on the wet end and further that those on the dry end were not subjected to malalignment, poor lubrication, etc. These remarks are only offered as it would seem that a larger bearing, all things considered, would decrease the cost of maintenance if applied on, for example, stretch rolls and felt carrier rolls on the dry end.

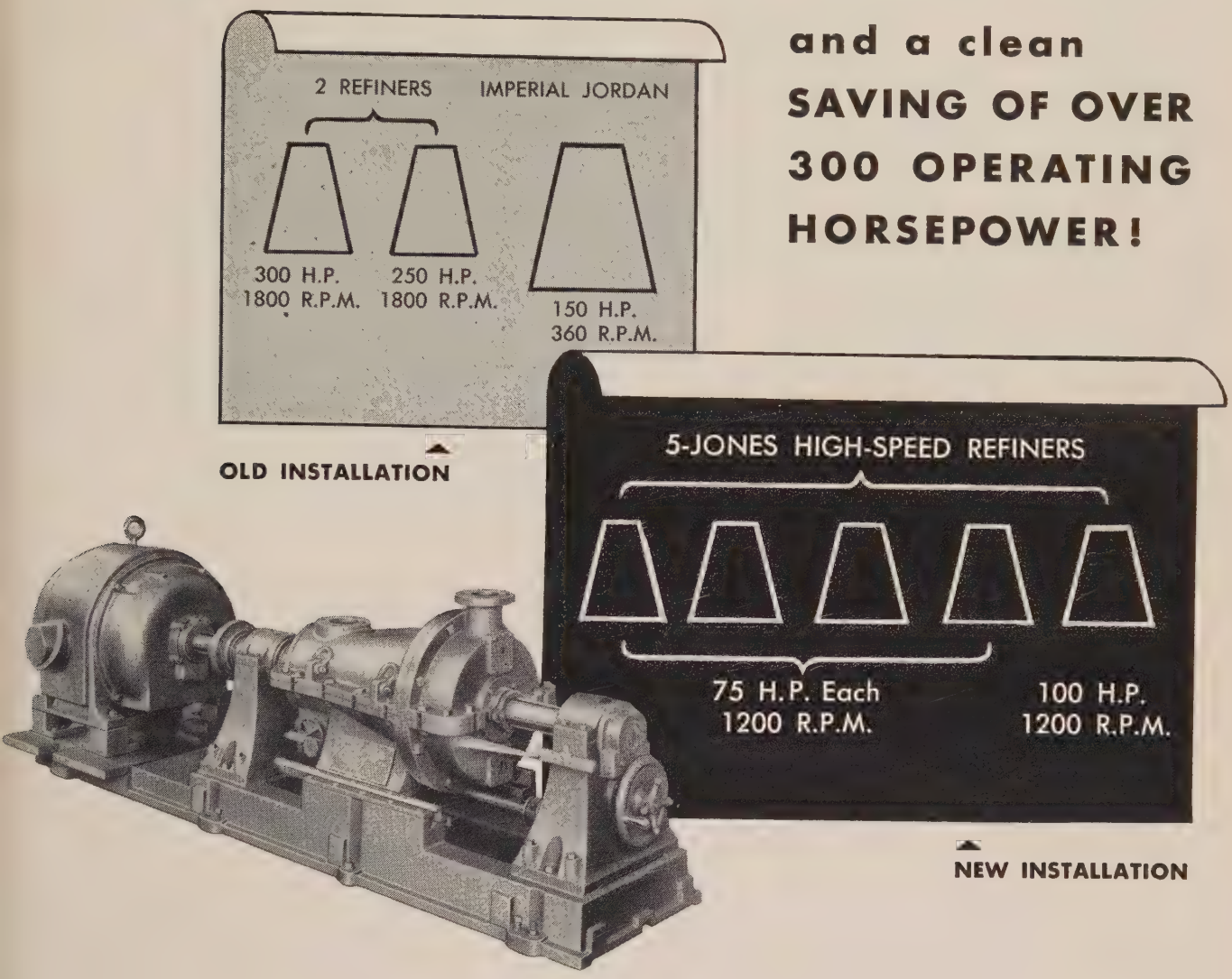
"The application of the "ladder" type method for permitting actual expansion must indeed, from all we hear, be a fine development on drier bearings as no doubt any restriction during the heating and cooling of this section of the paper machine must play havoc with the bearings.

"Another advancement, based on all we hear of machines more modern than ours, is the application of the bearings on the outsides of the drive gears instead of on the insides. The only bearing changed in the Plant in the past five years on the drier section necessitated a loss of eleven hours productivity.

"In concluding, what the undersigned believes to be pertinent remarks, the question still arises as to how much consideration has been and will be given the sizes of bearings on felt stretch rolls and felt carrier rolls in consideration of the maintenance costs as against carrier rolls on the fourdrinier. Actually more bearings have been replaced on felt carrier rolls in the press section and drier sections of paper machines the undersigned has been responsible for maintenance of than any

Dinner group at the Fourth Engineering Conference sponsored by TAPPI, Boston, Mass., Oct. 31, Nov. 1–3, 1949

Better Control More flexibility better preparation



and a clean SAVING OF OVER 300 OPERATING HORSEPOWER!

The refining equipment replaced (in this actual Jones installation) by Jones High-Speed Refiners was not old or obsolete or worn-out equipment. It represented some of the best current competititive thinking.

Yet Jones High-Speed Refiners actually produced improved stock — at a saving of over 300 operating horsepower. They save on maintenance cost, too. For more information, write for Bulletin EDJ-1011-A.

E.D. Jones — *E. D. Jones & Sons Company, Pittsfield, Mass.*

BUILDERS OF QUALITY STOCK PREPARATION MACHINERY

other section of the machine. As always with a paper machine full consideration should be given not only to the cost of repair but the cost of lost time. Personnel in the undersigned's capacity must face this daily and although prospective buyers do not wish added expense, the paper-machine manufacturer and bearing designer could create great and good reaction if the factor of slightly higher initial cost were properly weighed against future down time."

WILLIAM G. GRAY, JR.

MR. SPENCER: I am certainly happy that Mr. Gray had the thoughtfulness to put his comments down and send a copy of them to me, as you can recognize that they would be a most difficult group of questions to answer offhand. I have written out an answer and trust that it will be interesting to him as well as to all of us here.

In response to Mr. Gray's letter of October 5, I will start with the last paragraph that asks, "How much consideration has been and will be given the sizes of bearings on felt stretch rolls and felt carrier rolls on press and drier sections of paper machines in consideration of the maintenance costs as against carrier rolls on the fourdrinier wire section?"

It will be noted from the tables in the writer's paper that the same bearing size is suggested for all three mentioned roll locations of a machine coming within any speed and width grouping. The suggested bearing size of any grouping was actually calculated from the heaviest and most severely loaded rolls which is believed to be either the felt stretcher roll or the middle tier of the lower drier felt stretcher roll or the middle tier of the lower drier felt rolls in both cases of which the felt wraps around the roll approximately 180°.

After the selection of the proper bearing size was made to conform with the predicated average life, it was thought best to follow through with the same bearing size for the carrier roll of the fourdrinier wire. Since these are relatively few in number for the sake of standardization and for all of the number of the different bearing sizes to be kept in stock, actually smaller bearing sizes could with safety be used on the fourdrinier wire rolls.

Mr. Gray expressed the wish in the earlier part of his letter that more could be done to insure exclusion of water from wet-end spherical roller bearings. To this question it is my opinion that many of the common-bearing housing designs when carefully and accurately made and assembled, do a fair job in keeping water from entering the bearing. I refer here to the combined use of friction seals and grooving as a part of the end cover construction the use of bronze water flingers that are rigidly fastened and rotate with the journal and which also can form in their design a labyrinth with the end cover and lastly a stationary machine water shroud that is bolted to the bearing housing and is carried a considerable amount below the center line of the journal. In most similar cases the shroud will deflect white and wash-up water from reaching the aforementioned sealing arrangement. Most manufacturers of grease for the newer design of wet-end roller bearings use lime-based greases which are water resistant. But on older designs of bearing housings or on ones that are wearing out resort is made to sodium-based greases purposely for absorbing water and is heavily contaminated to emulsify with the water giving for a limited time good rust prevention. In such cases as these, the grease will eventually be washed out of the bearing so that relubrication at more frequent intervals is required. I simply inject that as a possible solution to Mr. Gray's comment.

Mr. Gray's fourth paragraph brings up the interesting fact that he obtains more bearing life on the stretcher and carrier rolls on his wet and press section than on similarly located rolls on the drier section, all things being equal as to bearing protection, alignment and lubrication. The one difference in bearing operation on the two sections of the machine is that the surrounding operating temperature in the bearing housing is higher in the case of the drier section. Assuming that the proper-sized bearing has been selected for the heaviest loaded roll in the drier section and keeping in mind that some lubricant manufacturers will use the same grease lubricant for both the wet and drier stretch and carrier rolls, I wonder if Mr. Gray's problem might not be solved by his again using a number two consistency instead of a number one consistency grease, that is, a grease with a higher melting point say 350°F. as compared to 200°F. Likewise, a higher viscosity say 600 SSU at 100°F. maximum as compared to 400 SSU would seem to be advantageous.

MR. GOLDSMITH: Thank you, Mr. Spencer. May I ask for some comments on this paper which touches a subject in which we are all so very much interested?

JOHN W. CROCKER, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y.: I would like to consider table-roll bearings as it is impossible to cover all the bearings which have been mentioned in Mr. Spencer's valuable paper. Table-roll bearings have been made from 3 inches diameter up to 16 inches in diameter. They have been made from 35-inch face up to 300-inch face. They have been made of brass tubes and of steel tubes rubber covered. They have been made fin-typed and Dandy-typed and they have been made of aluminum tubes rubber covered or Micarta covered. The variations which you get in these tubes make it very difficult to tie in with width of machine and speed in f.p.m. Our thought is that if it were possible to tie in the standardization to weight of roll and r.p.m., we could then set up a standard of bearing which could be applicable to all rolls. Would you mind commenting on that, Mr. Spencer?

MR. SPENCER: Mr. Crocker, I believe that it would be quite possible to take these tables as they have been presented and to convert them over to exactly the basis of which you're speaking. In the arrangement of these tables there was, of course, taken into account the weight of rolls and the speed of them. I think the tables could be rewritten along the lines of which you speak. It's a question of determining which would be the most useful.

MR. GOLDSMITH: We have more to discuss this afternoon than time will permit. We have another paper coming up and I do want to ask that as much be said as briefly as possible to allow time for the last half of the afternoon's program which is allotted to the materials. Mr. Dimmick of the SKF Company will present his discussion of Mr. Spencer's paper.

COMMENTS BY MR. DIMMICK:

"As manufacturers of spherical roller bearings for some 25 years, in fact as the originator of this type bearing, we are naturally interested in anything that pertains to its employment.

"We are highly complimented that the author of the paper just presented, has, in his list of literature cited, referred to papers by four members of our organization (R. H. DeMott, C. N. Benson, B. R. Sackett, and Dr. H. Styri).

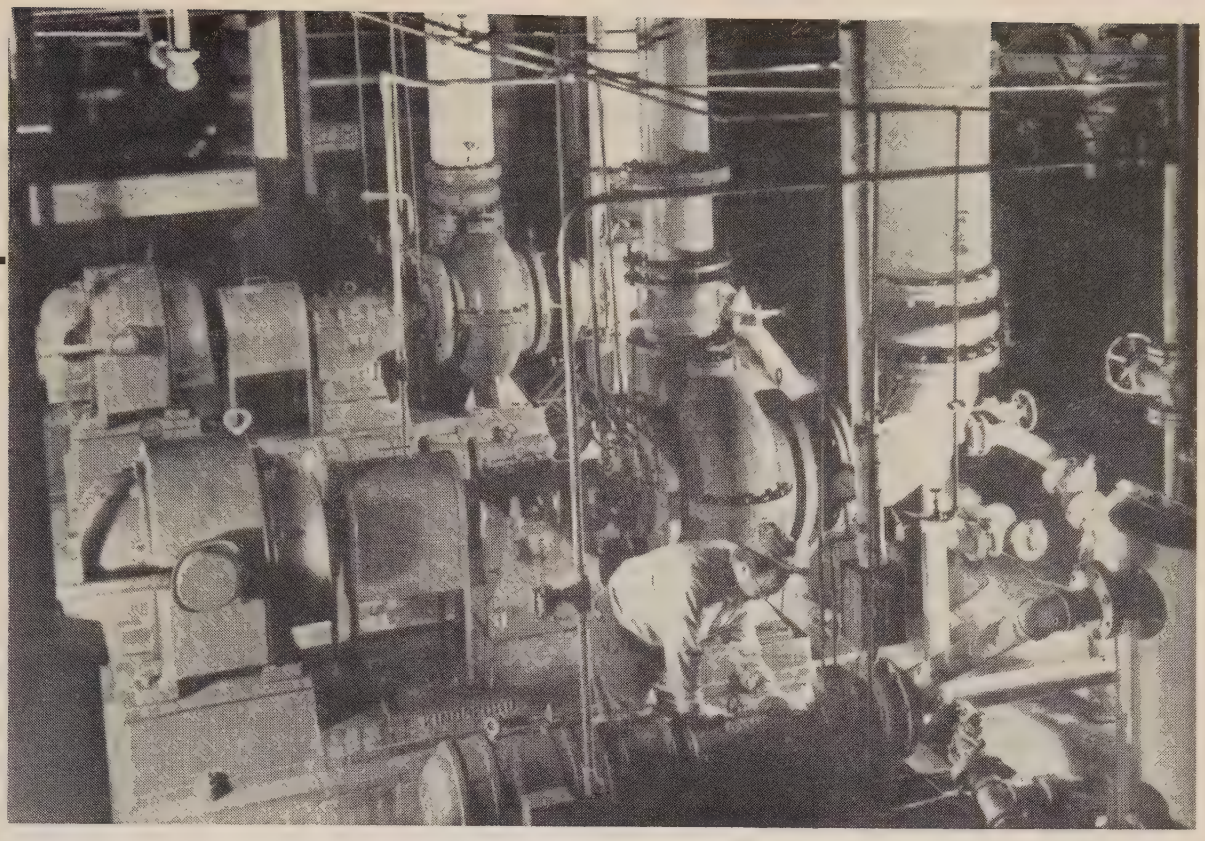
"The use of standard parts, economically produced in large quantities and easily obtainable, is not only desirable but essential from the standpoints of both the machinery builder and the user.

"Bearing sizes, including several series of spherical roller bearings, were rather well standardized in the early twenties and before. In the late thirties a general plan was worked out to extend existing sizes and series in a logical and orderly manner. As a result, a sufficiently broad variety is afforded to cover practically every requirement.

"Because of this basic standardization of the bearings themselves, the designers and builders have a considerable latitude of choice that all may exercise without penalizing themselves either from a standpoint of cost or availability.

"If, in the builders designs, standard bearings are used, the user is assured of good availability at fair and reasonable prices, when and as replacement may be required.

"It is generally considered sound procedure, particularly



For the Quality you want
...specify HOOKER CAUSTIC SODA

IF YOU find it necessary to clean your caustic storage tanks frequently because of sludge deposits, it's time to try Hooker Caustic Soda. Thanks to a recently improved purification process, Hooker Caustic Soda is remarkably free from those impurities that leave sludge deposits. Low in iron and sulfates, it is a high purity product—a purity that is uniform in shipment after shipment.

You can be sure, too, that Caustic Soda from Hooker will reach you with the same high purity that it leaves our plant. Tank cars are all equipped with special protective linings. To make unloading and handling easier in cold weather, each tank car in the Hooker fleet is completely insulated and equipped with steam coils.

Hooker's Technical Staff is also at your service to give you help in the use and handling of Caustic Soda.

Hooker Caustic Soda is available in solid, flake, or liquid form. Liquid is supplied in 50%, 73% and special grade solutions.

For analyses and specifications on Hooker Caustic Soda, write on your business letterhead for technical data sheet No. 735.

From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

4704 BUFFALO AVENUE, NIAGARA FALLS, N. Y.

NEW YORK, N. Y. • WILMINGTON, CALIF. • TACOMA, WASH.

HOOKER CHEMICALS

10-5

SODIUM SULFIDE • SODIUM SULFHYDRATE • SODIUM BENZOATE • CAUSTIC SODA • MURIATIC ACID • PARADICHLOROBENZENE • CHLORINE

when 24 hours operation is involved, to have on hand a stock of spares and spare parts. From the spare part standpoint it is highly desirable that the number of different sizes of bearings on a paper machine be kept to the minimum, consistent of course with due regard for the service life expectancy of the bearings employed in all locations.

"A number of years ago we gave consideration to this particular phase of the problem. As an example I refer to a publication entitled 'Paper and Pulp Machinery equipped with SKF Bearings' issued in 1935 in which we made the statement 'The same size of bearing is used for all the wire and felt carrying rolls in the same machine.' This is one of the points set forth in the author's paper. Our efforts and recommendations along this line actually antedated by some few years the 1935 publication to which I have made reference. Additionally, there have been many cases where the bearing size used on wire and felt rolls has been properly used on still other points of application on the same machine.

"Similarly there have been numerous other cases where duplication of use of a size on the same machine has been effected. This size duplication we believe is of more value to the user, than whether or not his machine has the same bearing size at any given location as a machine in the next county. This duplication of use of a size goes hand in hand with the idea of using the least number of different sizes on a machine.

"Many years ago we found that some designers desired, and insisted upon, different journal sizes than other designers for the same basic application. The reasons were many and for the most part valid. It must be appreciated that even though the same basic application were involved, the design arrangements differed. We did not feel then, and we do not today feel that we as bearing suppliers should recommend journal sizes. By proposing an 'across the board' standard a specific journal size is certainly recommended.

"Our approach to the problem of standardization has been to cooperate with the individual builder and assist him in any and every way to develop standards of his own that are strictly compatible with his specific designs, specific requirements and arrangements, and desires, but without attempting to channel or influence his size usage into the same size or sizes that his competitors may use. We can, in discussing the matter with one specific builder, ascertain quite definitely that journal sizes finally involved meet his specific requirements and desires. We feel that this method benefits both the user and the builder, and yet does not cramp the designer's individual ingenuity.

"We have been involved in a number of standardization programs and suggested programs, but every bearing involved is a standard bearing normally readily and easily available.

"When, as, and if the several builders and designers are willing to standardize their several constructions, specific design features, arrangements, etc. too numerous to mention, then, and only then, would an 'across the board' bearing standardization be built on anything approaching a firm foundation.

"In working with designers and builders in establishing their own standards we have repeatedly made substantially this statement. 'We believe that there are numerous cases where we must both exercise sound judgment based on facts in a specific case, good common sense, and field experience and future results. We are not proposing specific adherence to a selection table, but rather offer it as a general guide and basis for future thinking and action.'

"In conclusion: we do not believe that a standardization across the board as outlined—for all builders—is the best solution, as it would leave the designer little if any latitude and would cramp his ingenuity and hence retard progress."

MR. GOLDSMITH: We're indebted to Mr. Dimmick of the SKF Company on the discussion of the paper by Mr. Spencer of The Torrington Company. I think we're very fortunate in having two specialists give their views this afternoon on this particular subject. Unless the author himself wants to comment on Mr. Dimmick's discussion, I feel we should go on due to the limitation on time. Mr. Spencer, do you wish to comment on Mr. Dimmick's paper?

MR. SPENCER: I have no comment on the paper.

MR. GOLDSMITH: We're very appreciative of Mr. Spencer and those who have contributed to this discussion this afternoon.

Conveyors in a Pulp and Paper Mill

The session of the Materials Handling Committee held during the Fourth Engineering Conference of the Pulp and Paper Industry, Boston, Mass., on Oct. 31, 1949, was opened by George R. Wadleigh, Consulting Engineer, New York, N. Y., *Chairman*. At this session Samuel L. Foster, Chief Engineer of the Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich., presented a paper on "Conveyors for Materials in a Pulp and Paper Mill." (*Tappi* 32, No. 10: 449–453).

The following is a discussion prepared and presented by A. T. Hurter, Consulting Engineer, Stadler, Hurter & Co., Montreal, P. Q.:

"Mr. Foster's paper relating to conveyors for materials in the pulp and paper mills makes particular reference to the K.V.P. Co.'s mill at Espanola and is very well written. For the benefit of other readers of Mr. Foster's article, it has to be recognized, and this is not fully expressed by Mr. Foster, that the K.V.P. Co. reconverted an old existing mill which was previously owned by Abitibi Power & Paper Co., and was inoperative for a period of over ten years.

"It is of course very difficult to provide new material-handling systems to fit existing mill buildings which have been designed 40 or 50 years ago.

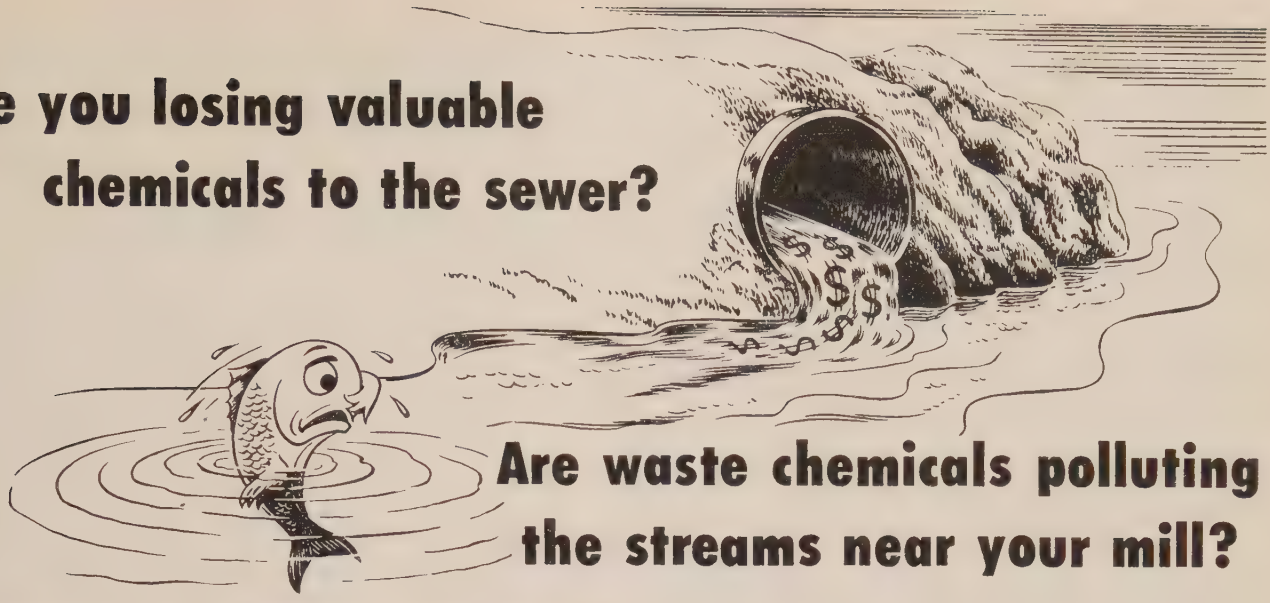
"The handling of material is today quite a problem in every pulp and paper mill, especially in view of the rise of labor cost as well as the cost of raw materials, especially wood as cut in the bush. The management of many mills has recognized that a lot of labor can be saved by adopting new handling methods so as to cut down the wood cost until it is converted into the final product.

"Going back to Mr. Foster's paper there are of course many individual items which are uppermost in the minds of many plant engineers of pulp and paper mills.

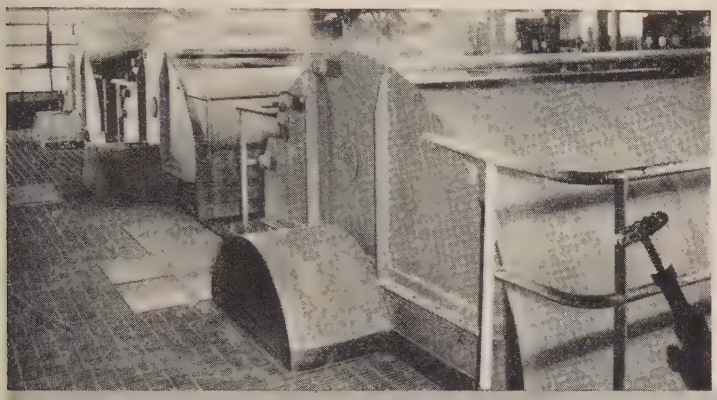
"One of the items I should like to mention at this time is that the various railroads have not yet given consideration to a better type of railway car for the conveyance of pulpwood. The only railroad so far as the writer knows which has lately put in service special pulpwood cars, for the transportation of 4-ft. wood, is the Bangor and Maine Railroad. In Canada the writer has noted that the Algoma Central Railway as well as the Canadian National Railway and the Canadian Pacific Railway, on some divisions, have adopted flat cars for the transportation of 4-ft. wood by providing a stiff back, either made from steel or wood, at each end of the car to allow piling of two rows of 4-ft. wood crosswise. There is a sill running lengthwise on each car, about 6 inches high, to allow piling of two rows of 4-ft. wood, so the wood pile slants toward the center to prevent sticks from dropping off the cars. Transportation of wood loaded on flat cars is, however, limited to certain divisions or branch lines and seldom used on main lines. There are also some cars available with open tops where you can pile wood into them more easily than into box cars. They are of a similar type as cattle cars, in other words they are not fully boarded up.

"The main trouble the writer has observed in using box cars for the transport of pulpwood is that the load generally slips inside the box car and prevents the opening of the doors. In many cases doors are damaged before they can be opened. In some cases the doors had to be adjusted to give smooth surface for easy opening, but the cost of this had to be ab-

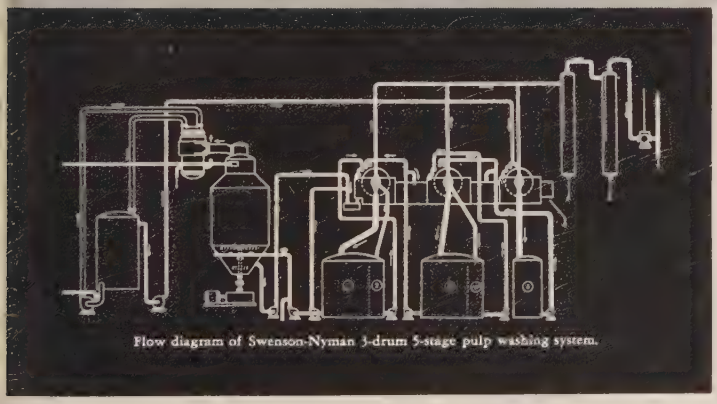
Are you losing valuable chemicals to the sewer?



Are waste chemicals polluting the streams near your mill?



Then it's time to investigate the Swenson-Nyman Pulp Washer, which operates as a closed system. Multi-stage countercurrent washing minimizes dilution . . . eases evaporator loads . . . saves steam and fuel.



Flow diagram of Swenson-Nyman 3-drum 5-stage pulp washing system.

Each Swenson-Nyman drum provides 2-stage washing. Mills, today, are using two and three drums in series—washing pulp in 4, 5, or 6 stages for greater economy.

Swenson-Nyman Pulp Washers and other Swenson equipment of interest to pulp mills are described and illustrated in Bulletin E-108—write for a copy, today.

SWENSON

SWENSON EVAPORATOR COMPANY

DIVISION OF WHITING CORPORATION
15697 Lathrop Ave. Harvey, Illinois
Eastern Sales Office and Export Department:
30 Church St., New York 7, N. Y.
In Canada: Whiting Corporation (Canada) Ltd.,
47-49 LaPlante Ave., Toronto 2

- Evaporators
- Pulp Washers • Filters • Causticizers
- Digester Blow Condensers
- Surface Condensers
- Turpentine Condensers • Deckers

sorbed by the pulp or paper company, or contractor furnishing the wood.

"In regard to the unloading of the wood arriving at the mill consideration has been given lately to using a similar method for unloading box cars with pulpwood to that generally applied for the unloading of grain or ore. Some preliminary studies are presently being made in the writer's office, based on an inquiry received. A lot of labor could be saved by applying mechanical unloaders at any pulp and paper mill receiving large quantities of pulpwood every year.

"Mr. Foster in his paper did not elaborate very much as regards the storage of wood within the mill yard, especially at any mills where wood has to be stored to carry the mill over the entire winter. This may apply more to Canadian mills than U. S. mills and in this respect various methods of storing pulpwood have been adopted The most commonly used method of storing wood is by means of a stacker. There are stackers of the movable type, as mounted on rails running at right angle to the conveyor. There are double arm stackers which are structurally easier to build. Furthermore, these are pivoted stackers which can store wood in a pile similar to a doughnut shape. However, due to some of the disastrous fires on pulpwood piles the Fire Insurance Companies now limit the size of the piles to 25,000 to 30,000 cords, which has become more or less of a standard size.

"Other methods of piling wood in the yard are by means of a cable conveyor over suspension bridges, which has certain advantages as the return strand of the cable conveyor is generally carried below the ground level and acts as a reclaiming conveyor during the winter months. In all cases the economy of various systems are closely analyzed before the most suitable type is adopted.

"Regarding Fig. 6, as referred to in Mr. Foster's paper, which shows the jack ladder of a parallel-type log haul-up as recently built in a Canadian mill, Mr. Foster omits to state that this particular jack ladder was also equipped with artificially created current through the jack ladder which floats the wood on the chains. This particular installation was designed by the writer's company in connection with the Long Lac Pulp & Paper Co.'s new mill, and allowance had to be made for variation in the water level as the pond was only recently created in conjunction with a power development adjacent to the mill.

"Due to the improvement in the type of belts furnished by various rubber companies, more belt conveyors have been adopted recently by many pulp and paper mills. This is primarily due to saving in maintenance and power consumption, but it has also been noted that belt conveyors of great lengths can be installed, which was not possible with cable or chain conveyors. One of the longest belt conveyors recently installed was at Long Lac Pulp & Paper Co. from the slasher building (shown on Fig. 6 on Mr. Foster's paper) to the wood room, a length of 1630 feet and carries up to 100 cords of wood per hour. The only trouble which has been observed in the use of belt conveyors is that they have to be operated continuously during the winter time, over week-end shut downs, so as to assure safe operation during the entire week. There is of course the possibility of the belt freezing to the idlers or head pulleys if not operated under severe cold weather such as 20 below zero, or lower.

"Belt conveyors are especially well suited for sorting conveyors after barking drums. Many mills have increased the width of the sorting conveyors so as to give the operators a better chance to sort the wood properly to assure clean wood going to the pulp and paper mill.

"The writer would also like to point out at this time that today the storage of chips has lately been given more consideration and the adoption of building chip storage bins on the ground is standard for any new installation. Chip storage can be increased in size so as to operate the wood handling system only during one shift per day, which in some mills has resulted in considerable savings. An economical size can be built to give storage for any amount of hours and generally most new installations provide for chip storage bins of capacities to provide chips for the digesters for 36 to 48 hours, or even more.

"The writer has given considerable thought recently to the development of chip storage and has developed a new type of reclaiming machine. A full description of this will be the subject of an article to be printed in one of the next issues of *Pulp & Paper Magazine*. Not wanting to elaborate at this time as to the type, the writer would like to point out that his chip bin gives opportunity for blending the chips while being stored and avoids any arching within the chip bin and assures uniform reclaiming from the chip bin, in any desired quantity, to feed the digesters at a uniform rate. Anybody interested in this article may obtain a reprint from the Improved Paper Machinery Co., Nashua, N. H., who are licensed to build the twin screw conveyor reclaiming device in the U.S.A. It might be of interest to you that Coosa River Paper Mill, which is not under construction, is using that type of chip bin. There are already four of these installations in Canada.

"The type of chip conveyor used at Espanola to the digester which is housed in an 8 ft.-diameter steel tube is unique of design and should be given special recognition. The cost of this conveyor gallery is cut down to a minimum since not only is the tube acting as a support but also as an enclosure of the conveyor gallery, which is a great feature especially in a climate as observed at Espanola.

"As regards the handling of mill supplies, it is recognized that many mills have not given due consideration to the savings which can be made by giving more attention to this matter. It is often not realized that the amount of regular mill supplies arriving at a mill and the handling of these materials gives the plant engineer an opportunity to adopt some unique devices. It is important, as mentioned by Mr. Foster, to cut down dust as much as possible. Just as much attention should be given to the handling of regular mill supplies as to the handling of wood.

"As the price of coal has risen rapidly during the last ten years it is essential for any mill to provide a good and proper coal-handling system. Depending on how the coal arrives at each individual mill, the most suitable handling system has to be selected to suit its particular requirements. There are many types of coal-handling systems. The dust prevention problem should not be overlooked when considering the location of the coal pile in relation to the process buildings so as to prevent coal dust entering buildings, as it may easily find its way into the process. Coal is relatively easy to store: it does not require any shelter and the supply depends on the size of coal bunker provided over the boiler. Most of the coal-handling systems are operated on one shift.

"The hardest problem in any mill is the handling of bark. Today bark is looked upon as a fuel just like coal or oil. Of course it has to be properly prepared so it can be burned at a reasonable efficiency. Bark and rejects are generally not available in a regular supply and, therefore, it is difficult to provide proper bark storage facilities so as to give uniform feed to the boiler. One of the many problems in burning bark is the removal of water and there are a number of bark presses today on the market. New ones are under development so as to reduce the moisture content in bark and other rejects mechanically to 50, maximum 55%, at which percentage it maintains its own combustion. Many mills have a large bark and reject pile in the yard which today is worth valuable money as a fuel.

"One of the many points also to be considered in an economic material-handling system is the proper layout of transfer points from one conveyor to another. It should be laid out in such a way that no manual labor is required to adjust congestion of material at transfer points.

"There are many other points in a material handling system

AN-BAC...

ORR'S ANTIBACTERIAL PAPER MILL FELTS

What makes felts seem to wear out when they are lying idle on the paper machine?

Why do felts unaccountably tear off the machine after a week-end shutdown?

Why do felts develop holes in 20 to 30 days on the machine in spite of actually running only five to ten days?

THE ANSWER IS BACTERIA.

Though you can't see them, you can see what they do.

As everyone knows, bacteria are always in the air to attack dead animal and vegetable matter. Nature has made this provision in order to restore the fertility of the soil.

The presence of moisture in paper mill felts in the mill makes the wool fibres an inviting feast for bacteria! They simply follow their inherent urge to grow and multiply in such an environment.

Knowing that bacteria are always on the alert to infest paper mill felts, the logical thing to do is to apply preventive measures. And that's exactly what we do when we give Orr felts the AN-BAC antibacterial treatment.

MORE FACTS ABOUT BACTERIA AND AN-BAC

Bacteria rob paper manufacturers of many days of potential felt life every year.

Bacteria-injury can be seen in nearly every used felt.

Bacteria cause the loss of many tons of production on account of excessive shutdowns for felt repair and replacement.

AN-BAC FELTS are treated by a special process which makes the wool resistant to bacterial attack.

AN-BAC FELTS solve the problem of paper mill felt decay.

AN-BAC FELTS start fast . . . last long.

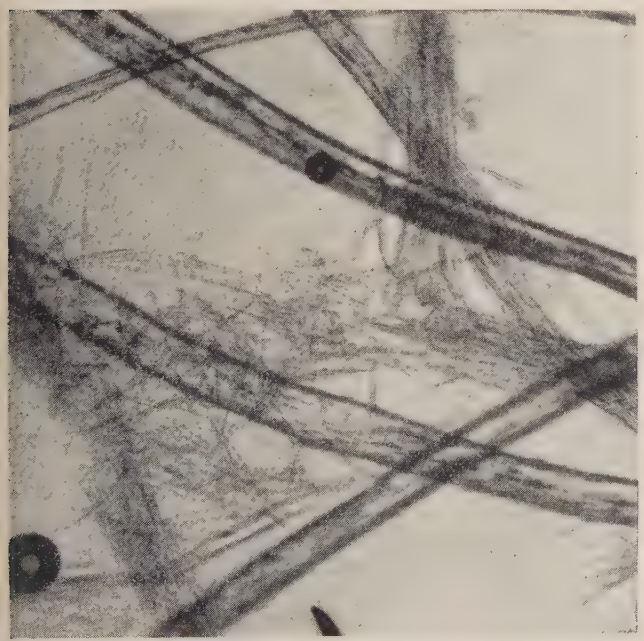
Testing of over 800 ORR Felts has proved the value of AN-BAC treatment.

Order your AN-BAC felt today.

Discuss your felt problems with your ORR representative.

GET THE LONGEST RUN FOR YOUR MONEY WITH ORR'S AN-BAC FELTS.

EFFECTS CAN BE SEEN, THOUGH NOT THE CAUSE



THE WORK OF BACTERIA

Here's a microphotograph of moist wool after only FOUR days of uninhibited bacterial attack. The disintegration of the fibres is clearly visible. This is what generally happens to untreated paper mill felt, especially during periods of idleness.

STERILIZATION AVERTS DAMAGE

Above is a magnified view of moist wool, AN-BAC-treated, after 28 days of exposure to bacteria. You can see that the fibres are undamaged.

In comparing the two microphotographs, keep in mind the four days vs. 28 days. Bacteria work fast. Their number doubles, trebles, or quadruples every hour under favorable circumstances.

THE ORR FELT & BLANKET CO., PIQUA, OHIO

Printed in U.S.A.

TAPPI Engineering Conference Group at Lafayette House during visit to Bird Machine Co., Foxboro Co., Draper Mfg. Co. and Bird & Son Co., Nov. 6, 1949

at every pulp and paper mill on which discussions could be brought up at this meeting.

"In conclusion the writer wishes to express, in the name of TAPPI Fourth Engineering Conference, appreciation of Mr. Foster's valuable paper, describing handling facilities at the mill of the K.V.P. Ltd. and bringing some of its excellent features to our attention."

A. T. Hurter *Montreal, P. Q.*

Hydraulic Subcommitte Round-Table

The Engineering Research and Machine Design Committee Round-Table meeting held during the Fourth Engineering Conference of the Pulp and Paper Industry at Boston, Mass. on Tuesday afternoon, November 1, 1949, was opened by Philip H. Goldsmith, Chairman and immediately turned over to K. J. Mackenzie, Chairman of the Hydraulics Subcommittee.

Mr. Mackenzie reviewed the reason for the setting up of a Hydraulics Subcommittee at the Buffalo meeting last year. He then reviewed the data covered in the preliminary report of the Hydraulic Subcommittee as published on page 79A of the September issue of *Tappi*, showing that a survey made by the Hydraulics Subcommittee of all pump manufacturers in the United States manufacturing paper stock pumps has produced data which indicated that there was considerable confusion in the calculation of pipe friction loss for paper stock in pipes and that there was ample justification for the Technical Association to set up a special committee to investigate and clarify the situation.

Mr. Mackenzie then reported that some work done at the Technical University at Darmstadt, Germany, in 1935, seemed to contain some valuable information, but this work had never been translated into English. During the last year the Hydraulics Subcommittee undertook the translation of this work. This had been completed and is ready for publication in *Tappi*.

Mr. Mackenzie then reviewed this work of Brecht and Heller on the pipe friction loss of paper stock suspensions, showing 37 slides of the charts and graphs which are a part of this study.

After the presentation of the slides Mr. Mackenzie warned against using the absolute figures presented in this work because he felt that the short length of pipe ahead of the manometer taps might possibly introduce an error in the manometer readings. He felt, however, that the relative results with respect to consistency, slowness, temperature, fiber-length, load, etc., were valid.

Mr. Gerbereux of the Worthington Pump & Mfg. Co. expressed concern over the distance between the second manometer tap and an elbow in the experimental layout. He felt that that also would tend to give a false reading.

Mr. Mackenzie then discussed the possibility of the Hydraulics Subcommittee organizing some work during the coming year on determining pulp suspension viscosities to see whether or not a relationship could be established between pulp viscosity and pipe friction. He described some work done on the Hercules high-shear viscometer which indicated that this instrument was not desirable for measuring pulp-suspension viscosities. He showed some work done on a Stromer viscosimeter which indicated that this instrument might be promising. It was agreed that studies would be made on this instrument during the coming year.

George B. Shaw, Ingersoll-Rand Co., inquired about work being done at the Anglo-Canadian Pulp and Paper Mills by Fischer & Porter in determining flow rates of stock by the use of rotameters.

Mr. Cuppen of the Fischer & Porter Co. then gave a brief description of the work they were doing, indicating that they had done an appreciable amount of work on the viscosity of pulp suspensions in order to develop a properly-designed rotor for their rotameter that would be independent of the change in apparent viscosity due to changes in consistency because they had found that the friction effect on their rotors changed quite appreciably with changes in consistency. Mr. Cuppen explained that all of this information would be available to the Hydraulics Subcommittee for their use in the present investigation.

Meeting of Hydraulics Subcommittee

At this meeting the proposition of the Executive Committee of the Engineering Division of TAPPI that the Hydraulics Subcommittee of the Engineering, Research and Machine Design Committee become a full committee to be known as the Hydraulics Committee was considered.

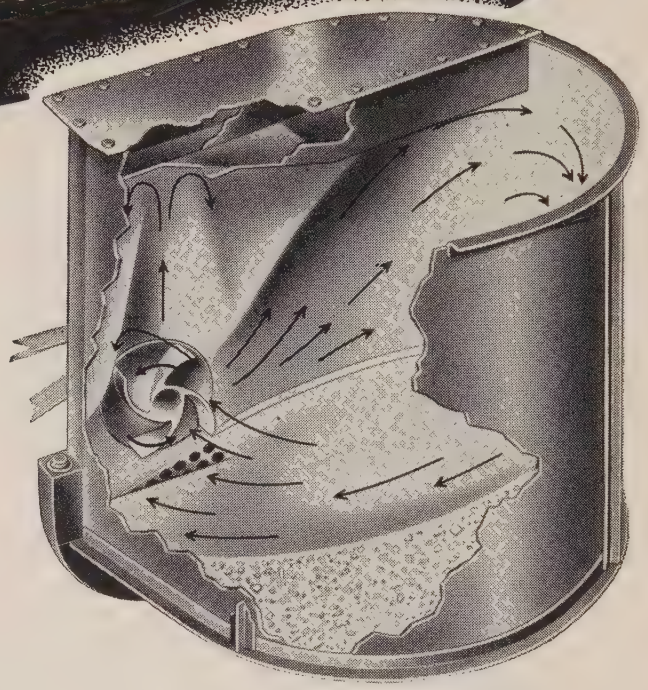
The scope of a Hydraulics Committee was discussed and it was finally agreed that this subcommittee would accept full committee status as the Hydraulics Committee provided that its present activities would be limited to the work that it is now doing on pipe friction loss and until a satisfactory completion of this project is arrived at no further activities will be considered.

It was agreed that photostatic copies of the work of Brecht and Heller would be immediately distributed to all members of the committee for their careful study as to whether or not this work should serve as a base for further investigation.

NOW THE NEW...

Cowles PULPER

BETTER, FASTER, LOWER IN COST WITH GREATLY REDUCED POWER INPUT



May Be Used Continuously or for Batch Pulping of Clean Stock

At last, a pulper that gives you the features you've always wanted. Truly revolutionary in its application of tried and proved pulping principles, the Cowles Pulper achieves efficiency and economy unsurpassed by anything else on the market.

Yet, it is more compact . . . demands far less head room . . . imposes greatly reduced floor loads: Savings that are achieved through elimination of costly and power consuming gearing. The result . . . a lower-priced pulper with a cost-saving drop in power input.

The side-drive design of the machine permits circulation of high consistencies with relatively small high-speed impellers . . . hence, sharply reduces the cost of the impeller and drive mechanism. A steeply-sloped bottom facilitates rapid drainage and will handle batches from 1/3-size to full-size with equal efficiency. There is virtually no splash at any operating level. Submergence is excellent at all levels and consistencies.

Like all Cowles equipment, Cowles Pulpers are soundly engineered and ruggedly constructed for long, trouble-free service. They embody proved hydraulic principles that yield high output with low power consumption. Write or wire for complete details.

The Cowles Company
INCORPORATED
1001 Trackside Cayuga, New York
Associates: Alexander Fleck, Ltd., Ottawa, Ont.

Status of the Pacific Coast Pulp and Paper Industry

LAWSON TURCOTTE

In the consideration of a subject so broad in nature as the status of the Pacific Coast pulp and paper industry, it is necessary to break it up into parts, so I will do this by asking and trying to answer three or four questions. First: Has the industry on the Pacific Coast kept in step with modern techniques in the use of fibers for pulp, paper, paperboard, and other allied products? The answer to this is definitely, yes.

Technical knowledge has brought to the forefront on the Pacific Coast the use of important new raw materials in the manufacture of pulp for paper, board, and many other fiber products. This is, to my thinking, the most important and far-reaching development over a relatively short period, and has a distinct bearing on long-range operations, stability of employment, and the retention of the American way of life. I might go back just a few years and refresh your memories by referring to a paper presented in Portland, at the TAPPI meeting in 1934, wherein, as pulping woods, western Douglas fir was not considered in the pulpwood figures, nor were the cedars, pines, larches, and hardwoods. All of these species are now being pulped to a greater or lesser degree on the Pacific Coast, and as time goes on there is no doubt that extension of these uses will be very material.

Technical know-how has also brought to the forefront a more complete utilization of our great Pacific Coast asset, "trees." This utilization will, of necessity, vary because of economics, and no doubt in the main approximately 55% of a tree, not converted to fibrous materials, will be integrated in the pulp operations and used as a fuel and power source as exemplified by the development of the MgO base for pulping woods. This is another recent outstanding development and, as you know, the first installation is now in operation at the Longview Pulp Division plant of Weyerhaeuser Timber Co. As in all new developments, there are the usual difficulties and delays in arriving at a 100% efficiency of operation, but I am sure that Weyerhaeuser Timber Co. will bring this development to a completely successful conclusion.

There is presently room for some utilization of the part of a tree not converted to fibers, and there have been important developments on the Pacific Coast in the field of converting this former waste to ethyl alcohol and compounds used for adhesives, plastics, and for the construction industry. This utilization will, in my opinion, expand as the Nation and the Pacific Coast area grow in population with their inevitable drain on some of the natural resources. As time goes on, members of TAPPI have an ever-increasing responsibility to find substitutes for some of the nonreplaceable natural resources.

The ever increasing new uses of fibers in our every day life attests to your vivid imagination, and the transfer of this imagination into action, especially in the paper and board manufactured products, in the field of rayon products, and many other products now considered a necessity in our every day life.

More in the mechanical technique can be cited: development of new equipment or improvements of older equipment, such as pulpers, defibrators, savealls, etc., all of which widens the field for use of fibers and eliminates waste. Probably the outstanding development on the Pacific Coast in this field is the hydraulic barker which is a relatively new and a proved successful operation, and is now considered a standard installation in all pulp plants on the Pacific Coast. No doubt many refinements and improvements will be made in hydraulic barking of large and small logs, as well as slabs, as time marches on.

Instrument control in paper and pulp mills on the Pacific Coast is in its most advanced stages.

One could go on at length in answering question No. 1, but I feel it can be definitely said that the Pacific Coast pulp and paper, and allied industries have kept pace with modern techniques.

My second question would be: Has the industry on the Pacific Coast realized its obligation to posterity by proficient utilization and conservation practices in the field of raw materials?

The answer to this question is interwoven with my answer to question No. 1, wherein I cited the broadening of the field of raw materials by use of practically all Pacific Coast woods in pulpmaking; by the installation of hydraulic barkers in practically every mill on the Pacific Coast, as well as the development of the MgO base and the utilization of the lignin for byproducts.

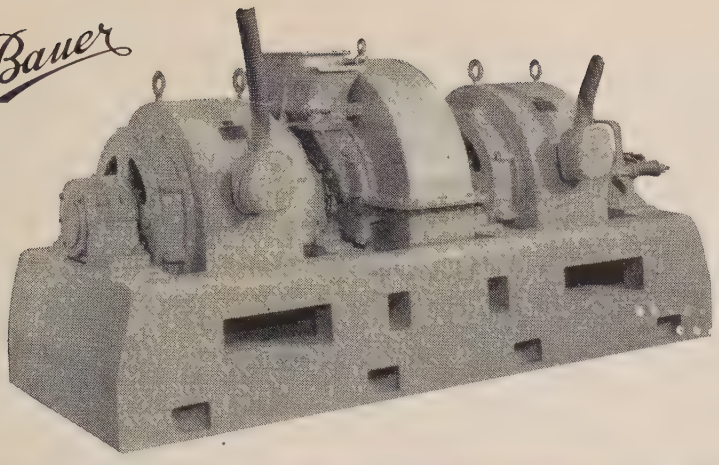
Now we can add to these developments the intelligent reforestation programs put into effect by the pulp and paper industry on the Pacific Coast, together with the salvage or secondary logging which is being carried on by the pulp and paper companies, as well as closer initial logging practices, all of which has as its effect the removal of every possible pulping fiber from the forests. Let us always be reminded that it is our obligation to do everything humanly possible to see to it that there is sufficient raw materials available for future generations of Americans, and certainly wood is one of the most essential raw materials, not only in peacetime, but is most essential should we ever again become embroiled in future wars. To this end, the Pacific Coast pulp and paper industry is carrying out a most comprehensive reforestation program, as well as a full utilization program, which together with use of new wood species, hydraulic barking, and other savings, has, I would venture to say conservatively, added 30% to the supply of raw materials for the pulp and paper, and allied industries. Such reforestation programs should be carried out by private enterprise as private enterprise does things in the most efficient and economical way. As a matter of fact, some of the logged off lands now in possession of our counties and states should be made available to pulp and paper companies on the Pacific Coast to round out some of their logged off timber holdings upon which they are carrying out programs of growing trees, whereas, in many instances, under county and state ownerships they are merely lying idle and are not in productive use.

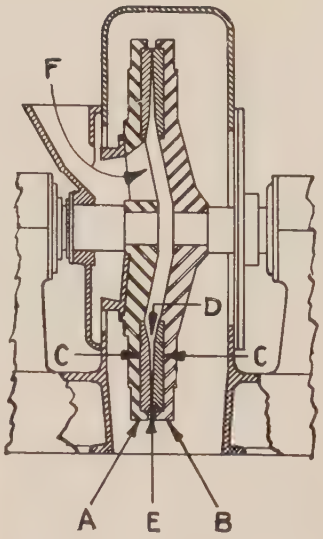
The third question which comes to my mind is: Has the pulp and paper industry on the Pacific Coast used sound judgment in its expansion programs?

The answer to this is definitely in the affirmative. Although the pulp and paper industry on the Pacific Coast has expanded during the past 10 years, it has been a most conservative expansion in conformity with population increases in our western states and British Columbia. The major portion of the many, many millions of dollars spent in the industry on the West Coast has not gone into expansion, but has been spent on bringing all of our plants up to their utmost efficiency readying itself for the competition which we all knew was coming sooner or later. In some instances it came sooner than expected, but by and large, the industry on the Pacific Coast is ready for this competition with the most modern plant and equipment available, and with an excellent labor force who also will benefit from this modernization program. All of this has been made possible partly from good profits, but our industry also has backed its faith in its own business by committing itself for substantial financing by way of

Lawson Turcotte, Executive Vice President, Puget Sound Pulp and Paper Co., Bellingham, Wash.

Bauer



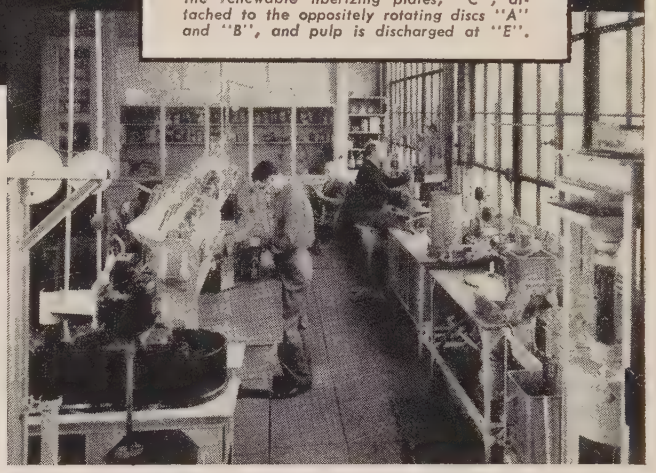


Chips enter at "F", pass at "D" between the renewable fiberizing plates, "C", attached to the oppositely rotating discs "A" and "B", and pulp is discharged at "E".

2 PROJECTS TO CONSIDER...

1. **THE USE OF THE FIBER PRODUCTS LABORATORY,** at Bauer, for study of your raw materials. The results accomplished for others are often truly surprising.

2. **THE USE OF THE BAUER PULPER** to give you long, pliable, free fiber. On this point the following table will throw light—show you how others are using Bauers.



● *THE FOLLOWING TABULATION COVERS ACTUAL INSTALLATIONS:*

Raw Chips, from Logs or Wood Waste, Slabs, Edgings, Tree Tops, Veneer Waste.	● For use in all types of Insulating Board, Wallboard and Hardboard. For Plastics of Various Grades.
Steamed Chips. Semi-Chemically Cooked Chips.	● For use in all types of Insulating Board, Wallboard and Hardboard. For Plastics and Roofing Felts.
Extracted Chestnut Chips. Extracted Pine Stump Chips.	● Semi-Chemically Cooked for Manufacture of .009 for Corrugating and for Wallboard.
Groundwood Bull Screen Rejects. Groundwood Knotter Screen Rejects. Groundwood Fine Screen Rejects.	● For Manufacture of Newsprint, Special Wrapper Stock and Board.
Hardwood Sulphite. Bleached and Unbleached Sulphite. Soda Pulp.	● Reduction of Shive Count and Pitch Spots, improved formation of Tissue, Book and other grades of Paper.
Kraft Knotter Rejects. Kraft Screen Rejects.	● For inclusion in various grades of Kraft Board and Kraft Bag Papers.
Sulphite Knotter and Screen Rejects.	● For use in Newsprint, also in Board and Specialties.
Waste Printed Paper, Waste Ledger. Waste Wet Strength Papers. Waste Corrugated Papers. Waste Paper in General.	● For use in Paper Board as Filler and Liner; for Auto Panel Board; for Wallboard Filler; in preparation for De-inking Processes; wherever freeness, freedom from cutting, uniformity, and complete defibering are required.
Bagasse Fiber. Licorice Root Fiber. Bamboo Fiber.	● For use in Insulating and Building Board. For special Paper, Boards, and Felt.

NEW FIBER PRODUCTS LABORATORY BULLETIN UPON REQUEST. PULPER INQUIRIES INVITED.

THE BAUER BROS. CO., SPRINGFIELD, OHIO

loans. Some of our natural markets for our paper and pulp products have not reappeared since the War because of the dollar shortages, and when such countries as China, Japan, India, Australia, and New Zealand resume normal commercial operations there, no doubt, will be further opportunities for expansion of our great industry on the Pacific Coast.

The affirmative answer to these three questions, of keeping pace with modern techniques, the industry's excellent record in the reforestation, utilization, and conservation fields, as well as modernization and expansion programs, has only been made possible through good earnings, and retention and expenditure of a major part of these earnings back into the business, plus very substantial additional financing running into many millions of dollars. Our government—whether it be Federal, State, or Local—must realize that a stable economy is necessary, that taxes must be equitable, and that the industry must have fair prices for its products, if we are to continue to keep our industry to its topmost efficiency and continue these most necessary conservation and utilization programs. We all realize that the removal from our forest of the lower grades and smaller pieces of timber is a marginal operation only possible when the industry is on a profitable basis after taxes, that reforestation programs run into millions of dollars, and all of this adds very materially to the cost of production of a ton of pulp or paper products. Therefore, our industry is entitled to protection from the products of foreign countries with their cheaper labor standards. Our Federal Government should give careful consideration to these factors in its tariff and trade agreements discussions with other countries.

There seems to be a general misconception that the United States is the high tariff country. This misconception is a matter of propaganda by many foreign countries and, most unfortunately, by our own State Department. Statistics are usually a rather dry subject, but I think it is worth while to say that in 1948 duty-free commodities accounted for 58.5 of total imports for consumption, and of this 58.5 of free imports, pulp and paper led the parade with 10% of the total. In addition to the imports on the free list, the duty on many paper products is being gradually reduced as provided in the Reciprocal Trade Laws, and paper products are always on the lists for such reductions. It is most important that everyone connected with the pulp and paper industry, including labor, should be vocal with their Congressmen and Senators in at least retaining the peril point determination in the Trade Agreements Act now before Congress.

The paper and pulp industry has been the means of constantly increased supply of dollars to foreign countries, of which there is so much talk today. Let us take a quick look at a few figures to prove this. In 1938 this country imported 2,357,477 tons of paper. In 1948 we imported 4,580,000 tons, an increase of 2,222,523. On the other hand, in 1938 we exported 208,064 tons of paper, and in 1948 385,000 tons, the net of which is a favorable balance of trade for foreign countries in 1948 over 1938 of 2,045,587 tons of paper. Just think! Over 2 million tons!

In pulp, even though domestic production has increased in considerable proportions, and one not familiar with the situation might think that this led to lower imports, the contrary is the fact. We imported from foreign countries in 1948 1,882,140 tons as against 1,551,254 tons in 1938, a favorable increase for foreign countries of 330,886 tons, and on the export side in 1938 we exported 140,484 tons, but only 93,782 tons in 1948. Figured in dollars, the favorable balance of dollars to foreign countries was $181,376,123 more for 1948 than in 1938 for pulp only.

I do not have the separate figures in dollars for paper, but for paper base stock and paper combined the favorable balance of trade in dollars for foreign countries in 1939 was $175,000,000, and in 1948 this favorable balance of trade in the same commodities had jumped to $616,000,000, an increase of $441,000,000 in 1948 over 1939. Therefore pulp and paper products have been a major source of dollars for foreign countries. I do not know of any other commodity which has provided in such a short space such an increase in dollars for foreign countries as pulp and paper products.

In conclusion, I would say that the status of the pulp, paper, and allied industries on the Pacific Coast is excellent, technically and physically, as well as financially, and it has a great future as our population constantly increases and many natural markets, now closed to us, are opened up, not only for our present products but for new products resulting from your most excellent research.

You need no reminding that the American way of life is the best and the proof, of course, is our high standard of living, but there are many who would have it otherwise, and we must, through research such as you carry on, furnish an ever higher standard of living so as to silence the nonbelievers.

Presented at the Fall Meeting of the Technical Association of the Pulp & Paper Industry, Multnomah Hotel, Portland, Ore., Sept. 12–15, 1949.

Hydraulic Barking—A Summary

L. E. HILL

THE ACCOUNT which is presented here will assume that there is a desire to know why many pulp mills have revised their wood preparation, and why the types of equipment now in use were designed to certain specifications. An attempt will be made to include enough detail regarding wood types and sizes and methods of handling before and after the hydraulic barker. It appears to be necessary to include such associated facts in order to justify the expenditures which in many cases have approached 1 million dollars. Even on the Pacific Coast it has been necessary to present much similar justification for the elements of size and design which are involved in these installations.

Affecting the development of hydraulic barking of large logs is the combination of mountains and climate of the West Coast. The mountains provide a sloping terrain which tend to break up and localize fires and thereby allow many areas to nourish a forest some hundreds of years old. The mountains also catch a very heavy precipitation over a large part of the year, encouraging rapid growth and very dense stands.

The lumber producers were the first industry to harvest the trees covering this area, and they developed the machinery necessary for the manufacture of boards and timbers. Over a hundred years of changing methods lie back of the logger who brought in material of suitable size and quality for the sawmills. Competition was keen, and only the best parts of the best logs could be delivered and processed to make a profit. The development of pulp and paper manufacture has widened the selection of species which could be used and changed the concept of the extent to which parts of any given tree should be reclaimed.

CONDITION OF PULP WOOD

Since it is now economically desirable to cut trees close to the ground and to process the tops in spite of many limbs, it has fallen to the pulp mills to devise methods of handling some very odd-shaped material. The butt sections produce diameters exceeding 8 feet in the fir and spruce logs, and

L. E. HILL, Resident Eng., Pulp Div., Weyerhaeuser Timber Co., Everett, Wash.

occasionally 6 feet in the western hemlock. The length of these large logs will depend upon the lifting and carrying capacity of logging machinery and transportation equipment, but may be as great as 40 or 50 feet. It is possible for one of these logs to weigh 25 tons, but there is usually some limitation in the handling equipment which reduces the weight to a maximum of $^2/_3$ that figure.

Near ground level the log section may depart from a circle, probably because the growth is greater where the major roots join the trunk. This produces a buttress which adjoins an indentation. Some of the hydraulic barkers are particularly well adapted to cleaning out the indentation or fold, and can be used to dig back into a seam of bark which penetrates below the surface of the tree.

When a stand of timber has reached the great age that is required in a natural forest for the production of very large individuals, it is likely to be "over-ripe." At this stage of growth many of the trees have been injured in such a way that fungus has attacked the heartwood, and has hollowed out a cavity which may extend as far as an entire barker length. A barker which relies upon a grip of firm wood at the ends of a log will encounter difficulty with this rather common defect and may be unable to process a log which is so defective.

Windstorms at times produce internal breaks in the wood of a tree. Later when it strikes the ground the trunk will slab off, or break with ragged and splintered ends. When such defects combine with large burls, caused by insects or disease, and the swellings around large limbs, the surface of a log can be extremely rough and resistant to any type of smooth handling.

The trees which come from mountain slopes are frequently curved in a long arc of considerable offset from a straight line. However this is caused, it is a defect which is very productive of trouble when such logs are brought to the mill. A sawmill would not accept such material. The pulp mill struggles to get these logs out of the railroad cars, through the shallows of the log pond, up a slip never intended to handle such eccentricity, and finally must bark them without hammering the barker to pieces.

By this time the honest logger has been completely confused. The woods are prelogged to remove "small trash" which would be broken to splinters by the big ones if left until the main operation. A clean sweep is made with the removal of large logs. And even then it is sometimes the practice to bring in equipment to salvage-log the material that remains. If such trash is desired, why not go the limit? Apparently he does, and at the pulp mill logs are found which have the slingshot structure which on a large scale is known to the logger as a schoolmarm. These are quite difficult to handle, especially when the straight material at either end is insufficiently long to make a normal barker piece.

The approved old-time method of removing most limbs was to break them off as the log was dragged in to the loading area. When smaller pieces are transported over soft ground for a relatively short distance to a truck loading station, many limbs are poorly removed. This is a factor of considerable significance with some barkers and may also cause delay in conveyors, on transfers, and at the chipper.

This rather extensive introduction could be greatly amplified by those who specialize in some part of the logging or lumbering industry. Enough has been said to indicate that a barker does not work any large percentage of the time on uniformly sized cylindrical shapes, but must be able to clean almost anything that comes to its entrance.

WOOD LOSSES

Now comes the million dollar question: why change from a process which has produced usable grinder blocks or chips, and invest a large sum in hydraulic barking? Of old, pioneers were at times as much animated by conditions in the homeland as by the tall tales of a utopia to which they were to direct their vessel or caravan. It is somewhat the same with wood preparation. It was the author's privilege to make a detailed study of all losses of wood incidental to mechanical cutterhead barking as it was practiced in 1935. It should be emphasized that this was in a comparatively new wood preparation plant supplying the Weyerhaeuser sulphite mill at Longview. Management, supervision, and operators were loyal, alert, and industrious in producing the best yield and best quality that the method allowed.

An incoming log was cut to quarters, or to slabs and cants, to a rectangular shape of 8 by $9^1/_2$ inches, and then crosscut to pieces not more than 12 feet long. Where the log size and shape required the removal of thin slabs, these were slashed to 4-foot lengths, picked from the refuse conveyor, bolted, and hand barked. The cants were barked in Stetson-Ross power barkers with concave cutter heads that would fit the contour of a log $21^9/_{16}$ inches in diameter.

During the four months required to make the complete study of wood loss there was sufficient time to observe all types of logs and conditions of operation, and to determine the loss which is inherent to mechanical cleaning as well as that arising from a necessity to maintain production, or to strike a balance of labor cost vs. material gain.

The logs were reduced to cants and slabs in a saw mill equipped with circular cut off saw, band saw and electric one man carriage, circular saw edger, and conventional gang slasher. The losses of wood were as follows:

One of the Men behind Eastwood Wires

Charles Worzel
—A "Weigh" to Better Wires

Responsible for weighing up metals for our melting furnaces, Charles Worzel knows that upon his accuracy depends the fine quality of our fourdrinier wires.

The base of the alloys is determined by the precise proportion of copper, tin and phosphor copper that go into making the phosphor bronze wires, and of copper and zinc that make up our brass wires.

A chemical analysis of each heat is made in our own laboratory.

The constant, complete control of our alloys is additional assurance of the high qualities of Eastwood Fourdrinier Wires and Wire Cloth.

EASTWOOD-NEALLEY CORPORATION • Belleville, N. J.

peroxide & PQ silicate
team-up
for whiter paper

Now, bleach groundwood pulp to the same brightness of more expensive types with peroxide and PQ Silicate. In one mill at 12% consistency and 1.5% sodium peroxide, the brightness of a groundwood-sulphite pulp was increased seven points on the GE reflection meter. PQ Silicate assists the process in these ways:

1. As a buffer to maintain pH in the bleach bath.
2. Prevents loss of oxygen when no bleachable material is present.
3. Aids the bleach liquor in penetrating into the fibre.

The degree of improved whiteness depends on the type of pulp, the amount of peroxide and other factors. May we discuss your bleaching problem?

PHILADELPHIA QUARTZ COMPANY
1141 Public Ledger Bldg., Philadelphia 6, Pa.

In addition to bleaching pulp, PQ Silicates are used in deinking, in beater sizing, coatings, adhesives, raw water and waste water treatment. Ask for further information.

PQ SILICATES OF SODA

Log cut off saw	0.10%
Head rig	3.25%
Edger	3.00%
Trim saw	0.15%
Slasher	0.80%
Refuse conveyor	2.00%
Total	9.30%

In the chipping plant, the losses of wood were found to be mainly concentrated at the Stetson-Ross power barkers, but with other contributors as well:

Stetson-Ross barkers	5.60%
Bolter and hand barkers	1.2%
Chipper	2.0%
Chip screens	1.0%
Total	9.8%

None of the losses mentioned include bark, but is sound wood which is purchased for manufacture into pulp but does not get to the digesters. Most of these losses can be reduced or eliminated by hydraulic barking. Since in principle the hydraulic barker will remove bark from a whole log, maximum savings in wood can be achieved if nearly all of the cleaned logs are fed to the chipper without further sawing or other reduction in volume.

Such savings are not theoretical but have been realized by actual installations of hydraulic barkers followed by whole log chippers. A paper (*1*) presented by R. J. LeRoux to the Michigan Division of the American Pulp and Paper Mill Superintendents Association lists a saving of 23% which was realized at Everett. Stated in another way, use of the barker obtained a reduction from 1032 to 790 feet log scale per ton of unbleached pulp. This amounts to a saving of 20,160,000 feet per year for a mill with an annual production of 96,000 tons of pulp. Taking a present day value of about $30 per thousand for hemlock, it can be seen that potential savings of the whole log hydraulic barker followed by large chipper are very large, although the exact figures will vary from one mill to another.

PRINCIPLES OF OPERATION

The idea that bark could be removed from wood by a high-pressure jet is not new. It would be interesting to collect the records of all early experiments and to learn to what extent the field had been explored prior to the time that the Pulp Division of the Weyerhaeuser Timber Co. began experimental work in 1935. One series of these Weyerhaeuser tests was performed with a lathe arrangement, and another series was run with a carriage for the log which could be run at varying speeds under a fixed nozzle.

It was during this period that design work was undertaken on a hydraulic barker of sufficient capacity to furnish cleaned wood for a pulp mill. Such design was not a simple process for many methods or arrangements are possible. This will be evident by referring to Table I which shows that many schemes are operating and many more (to the knowledge of the author) have not yet been tried, or worked into a design that looks very promising.

In practically all successful designs one common feature may be found. This is the use of very high-pressure water which is directed toward the log through an efficient nozzle. Many times it has been found that the use of slightly lower pressures has made a considerable reduction in the effectiveness of the stream barker or slab barker, especially when some of the barked pieces are harder barking than the average. No doubt many early experiments, such as those at the Saugbrugforeningen mill at Holden, Norway (where a pressure of 400 p.s.i. is used and mechanical barking with disk barkers and draw knives is used to clean up afterward) have narrowly missed setting off the trend which has been so evident in the last few years on the Pacific Coast.

A second feature of design could hardly be determined

until the use of, and need for, high pressure had been established and the pumps provided. The jet will perform more efficiently when its axis is perpendicular to the surface of the wood. The barker does not chisel off the bark. Instead, it erodes or explodes it off. Virtually all present designs hold quite closely to this principle which is reestablished in Everett each time that a projecting limb strikes the nozzles and swings them slightly in the friction joint.

When the experimenter has obtained pressure, and has pointed the nozzles squarely toward the log, he can speed up either the nozzle or the wood surface. Either can be the moving object insofar as speed is concerned. The nozzle is moved by the shotgun drive at Longview at 30 feet per second, or the log surface is moved at Bellingham at speeds up to 8 feet per second, with good barking results in each instance. When slower speeds are employed, it will probably be discovered that the kilowatt hours per hundred square feet of bark removed is higher than it need be.

Perhaps a word of caution can be inserted here. It is possible to suffer a lower efficiency in power used for barking and yet gain so much in lowered maintenance or operating costs that the extra expenditure for power is not seriously considered.

Although there would appear to be some advantage in a nozzle path parallel to the axis of the log, both from a survey of log contour and from the Weyerhaeuser experimental work, this does not appear to be so essential that it prevents successful operation with the other types which employ log rotation.

HYDRAULIC BARKER DESIGN

Making use of Table I as a guide, the various barkers will briefly be discussed. In most instances very good descriptions may be found in the articles which are listed in the bibliography.

14. Worthington Barker at Soundview and St. Regis (2)

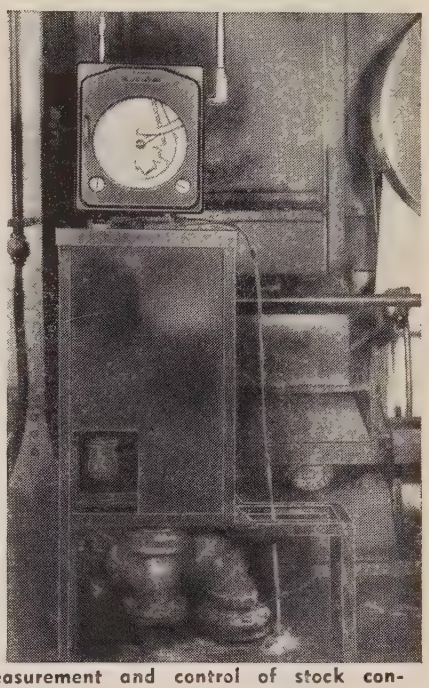
Whole logs are barked by this type of barker by passing them axially through the barking zone on ribbed rolls which can be run in either direction at a speed selected by the barkerman. Barking is done by a number of nozzles which are mounted on a lower and two side manifolds. The position of the manifolds is varied so that the nozzle can be kept at a selected distance from the log which is usually 15 or 16 inches.

The installation is provided with control valves on each nozzle so that only enough nozzles are used on any log to cover its full circumference. Extra water not required for a small log goes into the accumulators to be fed out by air pressure when required for a large log. Each nozzle is $^1/_4$ by $^3/_4$ inches and delivers about 160 g.p.m. When no log is in the barker all of the nozzles are off and a relief valve opens to pass enough water to keep the pumps from being overheated. Each pump is driven by a motor of 1250 hp. Two are used. The barker operates three shifts to supply the wood required for the production of 600 tons of bleached sulphite pulp.

Minor roughness, fluted and ribbed surface, and noncircular cross-section material is easily handled by this barker. Mild axial curvature can also be handled. Hard-barking logs must sometimes be passed through twice or three times in order to remove all of the bark. A very large log will have unbarked stripes which are handled by indexing after the first pass, and then putting it through the barking zone again.

Maintenance is, at present, very low and with development of better gearing for drive of rolls in the barker, would be very small indeed. Both installations are well thought out and beautifully constructed which doubtless had much to do with present low maintenance costs.

Stock Consistency Controlled and Recorded by new F & P CONSISTORATOR



F&P Consistorator in the mill of the Mersey Paper Company. Jagged line on instrument chart is a record of dilution water valve action . . . smooth line is a record of controlled consistency.

Accurate measurement and control of stock consistency is a vital factor in paper quality. F&P CONSISTORATORS hold dry stock content of pulp within ± 1/10 of 1% in the operating range of 1.5% to 4.5%. Compensation for changes in consistency at the beaters, the Jordans and the mixed stock chest is continuous and automatic. (The pneumatic controller has 15-200% throttling range and automatic reset.)

Consistency changes are detected by a float. The bond between the float and the controller is magnetic, requiring no mechanical linkages. The eye-level chart provides a continuous record of water valve action and controlled pulp consistency. Alarm sounds when dilution water demand exceeds supply. Wetted parts are made from type 316 stainless steel. The first cost of the F&P CONSISTORATOR is low, and maintenance is negligible. Catalog 77 gives more details.

CLIP COUPON — MAIL TODAY!

☐ Please send me a copy of Catalog 77, "CONSISTORATOR Consistency Controller."

Name _____ Position _____

Company _____

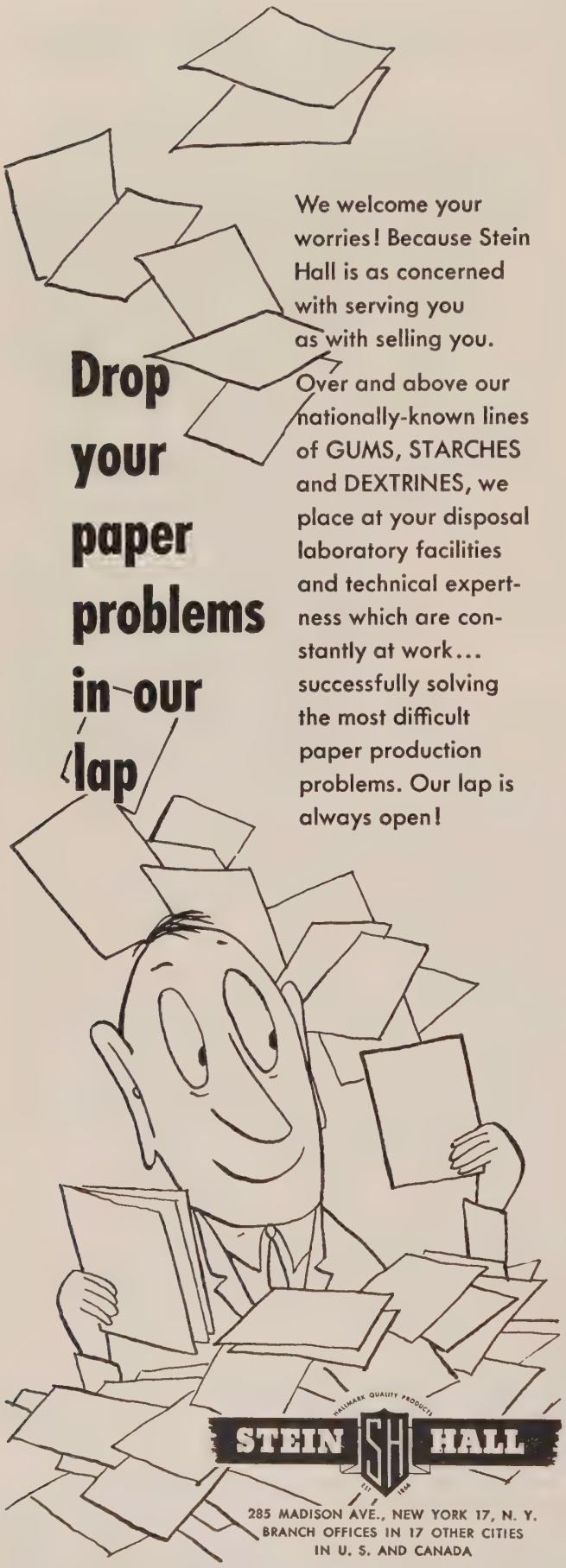
Street _____

City _____ State _____

FISCHER & PORTER COMPANY

Dept. OP-7P Hatboro, Pennsylvania

PROCESS CONTROL INSTRUMENTS


We welcome your worries! Because Stein Hall is as concerned with serving you as with selling you.
Drop your paper problems in our lap
Over and above our nationally-known lines of GUMS, STARCHES and DEXTRINES, we place at your disposal laboratory facilities and technical expertness which are constantly at work... successfully solving the most difficult paper production problems. Our lap is always open!
HALLMARK QUALITY PRODUCTS
STEIN HALL
EST. 1858
285 MADISON AVE., NEW YORK 17, N. Y.
BRANCH OFFICES IN 17 OTHER CITIES
IN U. S. AND CANADA

1B. Cant Barker with Oscillating Nozzle

At the Washington pulp and paper mill at Port Angeles a barker is in use which feeds slabs or cants past the nozzles using the feed rolls of a Stetson-Ross barker. In place of the former mechanical cutterhead, the jet of water is so mounted that it can be oscillated from side to side and thus cover the entire width of the barked surface. The water is supplied at 1200 p.s.i. The volume is 500 g.p.m., requiring a pump driven by a 450 hp. motor.

It is obvious that an installation of this sort does not gain all of the advantages in wood savings which are obtained from the plant which is designed to bark whole logs and thereby eliminate almost all saw kerf. If we survey such a project as a proposed wood supply for a small mill, it is evident that labor must be expended in sawing the logs to appropriate small size. The maintenance of saws has been found to be more costly when it is necessary to cut through bark which often contains much abrasive material. Even with saws of the thinnest practicable gage much wood is lost in sawdust to be reclaimed as fuel at one tenth its initial value. The barker has to handle nearly the same area as it would when handling a round log but must care for a larger number of pieces with chance of increased delay between pieces. It is true that to care for the whole log it is necessary to make a heavy investment in chipper and drive, but the total power consumed is likely to be about the same.

Special conditions will at times justify retention of some of the steps of the old method of wood breakdown before chipping, but it must be recognized that this is not the method by which the maximum advantages of hydraulic barking have been obtained.

The reported capacity of the machine is 64 thousand log scale in 8 hours, or about the amount of wood required for 75 tons of unbleached sulphite per day.

1D. Ring Barker

For many years the most convenient storage for logs of varied sizes has been a pond, and a log haul has been the usual way to bring logs from storage into a mill. Here is a place where the logs move one at a time, and at a speed within the capacity of an efficient barker, if such a machine could be devised for this location.

The ring barker is aptly described as to its shape. The log passes through its center, approximately. The nozzles are in the inner wall of the ring, in pairs which balance the thrust from jet reaction. The inner part of the ring is given a rapid rotation by a suitable drive such as V-belts. The outer part is nonrotating framework and water channel.

Between the stationary outer shell and the rotating inner ring is a packing which reduces leakage of high-pressure water to a nominal amount and prevents metal to metal contact which would result in galling or welding. The development of a suitable packing has been the triumph of this design and has only lately been accomplished.

Operation is relatively simple if the logs which come to the barker are within the size group for which it is built and do not carry limbs or horns which would strike and damage the rotating ring. Since the nozzles can be given a good speed relative to the surface of the log, a high efficiency may be obtained.

Where incomplete cleaning is obtained, it is the practice at the Port Alberni mill of Bloedel, Stewart, and Welch to pass the log back through the ring and then forward, as is done in the Worthington machine, thus barking it three times. Two sizes are currently made, a "small" unit 36 inches in diameter, and one 60 inches. The maximum diameter log is supposed to be 8 inches smaller in diameter than the ring.

In order to obtain good centering of a curved log, the ring can be made to move sideways and vertically. When

Table I. Types of Hydraulic Barkers

Nozzle movement	Logmovement									
	1 Axial, slow	2 Axial, fast	3 Axial, slow twist	4 Axial, fast twist	5 Axial, fast index	6 Transverse	7 Transverse, indexing	8 Transverse, slow rotating	9 Transverse, fast rotating, centered	10 Transverse, fast rotating, centerless
A. Stationary	Worthington barker (Soundview and St. Regis)	Hummel Ross slab barker	Worthington small log barker (Soundview)	Allis-Chalmers "Stream barker"	Weyerhaeuser experimental barker (Longview)	.....	.....	.....	.....	.....
B. Oscillating	Cant barker (Port Angeles)	Allis-Chalmers slab barker (Shelton)	Weyerhaeuser saw-log barker (Longview)	.....	.....	.....	.....	.....	.....	.....
C. Reciprocating	.....	.....	.....	.....	.....	.....	Weyerhaeuser first whole log barker (Everett)	Weyerhaeuser barker (Longview and Powell River)	Lathe-type barker (Port Townsend, Port Angeles, Hoquiam, and Oregon City)	Bellingham-type whole log barker
D. Rotating	Ring barker: Coaxial (Port Alberni) Barker with rotating nozzles: perpendicular to axis (Nanaimo)	New Allis-Chalmers slab barker (Grays Harbor)	.....	.....	.....	.....	.....	.....	.....	.....

Are your Calendering costs too high?

Take a look at your calendering costs. Are calender breakdowns and lost production eating up your profits? Put one Butterworth Calender Roll in the stack and time its extra hours of top-flight service. See how easy it is to cut down production costs and get smoother, better quality work.

Many of America's leading paper mills have standardized on Butterworth Calender Rolls after making this test. They found that Butterworth Calender Rolls pay off in outstanding finishes and increased production.

Butterworth Calender Rolls are made of the finest materials available—long staple cotton free of foreign materials and first quality paper of high rag content. Pretested for strength, hardness and density before delivery. Locked on the shaft by a special process, they can't slip, can't come loose.

We make calender rolls for all types of calendering in every size to your specifications. We can also refill your present rolls.

For full information, write or call H. W. Butterworth & Sons Company, Philadelphia 25, Penna. — Providence, R. I., 40 Fountain St. : : Charlotte, N. C., 1211 Johnston Building
In Canada—W. J. Westaway Company, Hamilton, Ontario

Butterworth Calender Rolls

such motions are provided it is necessary to introduce a flexible link in the pipe supplying high-pressure water to the outer ring. High-pressure hoses can be used for this purpose.

Since the pump at Port Alberni is driven by a steam turbine, it is possible to vary the pressure at the barker as well as control speed of travel of the log. Where such an arrangement can be worked out it allows the barker to be run at its best efficiency for the quality of wood which is being consumed.

The ring barker has not been operating long enough to pronounce final judgment, but it appears to be a type which has an excellent expectation of survival and improvement.

1D. Log Barker with Rotating Nozzles—Mill C, Canadian White Pine Co., Ltd.

As the log is moved forward in the direction of its length in a log haul or conveyor, it may be barked by nozzles at the side. If a pair of nozzles are mounted on an arm which is attached to the end of a rotating pipe, the water from each nozzle is able to sweep a much greater area of the log surface than if it were stationary.

The trial installation of this type of barker separates the nozzles about 30 inches. The jet is inclined toward the axis of rotation at an angle of about 15° so that during rotation the water describes a cone. When the shaft is rotated at 460 r.p.m. the stream moves at 36 feet per second as it traverses the surface of an average sized log.

The forward motion of logs in the conveyor is 60 f.p.m. As the nozzle head rotates at the rate of 460 r.p.m. the log is swept by a jet once for each $^3/_4$ inch of movement into the cone and again at the same rate leaving the cone.

There was earlier a rather long discourse on the irregularity of surface of logs. It appears to be a feature of this barker that its varying angles of repeated attack on the bark surfaces assist the streams in dislodging patches which are difficult for other types to remove. The initial installation uses two rotating heads, on opposite sides of the conveyor. The total water flow from four nozzles is 600 g.p.m. at 1350 p.s.i. With an efficient pump about 600 hp. is necessary. If such a rate of barking can be maintained during periods of adhering bark this machine can be classed as most efficient.

The problem of barking logs of large size can be handled as it is in the Worthington machine, by indexing and rerunning; or by the use of more than two rotating heads. Information on this barker has been obtained from H. A. Simons, consulting engineer of Vancouver, B. C.

2A, 2B, 2D. Slab Barkers

The arrangement in which the wood, which is to be cleaned, moves rapidly in the direction of its grain, without rotation, is useful for barking slabs. These pieces may be carried through the barking zone by chains, as in the Hummel Ross slab barker (*3*) or the Allis-Chalmers slab barker at the Simpson Logging Co., at Shelton, Wash. The slab barkers at Weyerhaeuser, Everett (*4*), and Bellingham (*5*) use wheels closely set on shafts. In each arrangement rider rolls are necessary to hold the relatively light pieces against displacement by the force of the water streams.

The Everett slab barker operates when either the main barker pump or the small-log barker pumps are available to supply water. With six fixed nozzles delivering about 1000 g.p.m., a surface nearly 18 inches wide can be barked at 220 lineal feet per minute. Slabs are fed in as fast as the operator can start them into the machine. When reduced volume of water is available from the small-log barking pumps, two of the nozzles are closed off by individual valves, and pieces are limited in width to about 12 inches.

CORROSION-PROOF
facts for Industry

Two new bulletins just off the press . . . packed with authoritative data on Corrosion Proof Construction Materials and Protective Coatings.

These bulletins may have the answer to your corrosion problem. Drop us a card today . . . we will send them promptly, without charge or obligation.

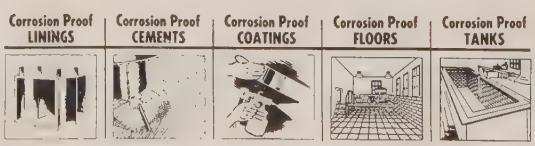
Corrosion-Proof
CONSTRUCTION MATERIALS
MCC-1

Includes plastic as well as natural and synthetic rubber corrosion-proof linings, corrosion-proof cements, corrosion-proof brick and tile sheathings.

ATLAS
PROTECTIVE COATINGS
BULLETIN 7-1

Covers an entire series of protective coatings, applicable on concrete, metal or wood surfaces for industry.

Write us at 22 Walnut Street, Mertztown, Penna.



THE ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN, PENNA. HOUSTON, TEXAS

At Shelton two nozzles oscillate transversely to cover each one-half the 14 inches zone width. The speed is arranged so that a sweep is made for each 4.2 inches of slab travel. Water supply is 400 g.p.m. at 800 p.s.i.

At time of preparation of this paper, a multiple outlet rotation nozzle had been built and was to be installed at the Grays Harbor Division of Rayonier. A valving arrangement admits water to one nozzle just as the preceding one is completing its sweep across the slabs and is about to reach a closure part of the valve area. It may be predicted that this will be a very economical way to cover a large area of slabs with a minimum water horsepower. This is an Allis-Chalmers design.

3A. Worthington Small Log Barker at Soundview

This design is arranged with a number of conical rolls in two rows which cradle the round log between the rows, and since each roll touches the log in a line which spirals around its surface, the log is both rotated and moved forward.

The nozzles are fixed in the upper part of the machine housing and accordingly have low-relative velocity to the barked surface. The largest diameter of the cone provides the propulsion, the only function of the taper being to guide a projection up to the driving rim. In this machine all rolls are set at a fixed angle to the axis. Doubling the diameter of log therefore advances it twice as far per revolution, and above an optimum size the nozzles will leave an unbarked strip unless provided with overlap which is excessive for smaller pieces.

Hinged pans help check splash out of the end of the housing, and also help hold down the log. However, rough logs will not be held down, but bounce violently. Small logs sometimes remain too long in the barking zone. The optimum size for the Soundview machine appears to be in the range of 8 to 14 inches diameter. Good capacity is obtained with smooth wood of that size, with a forward feed of 70 to 80 f.p.m.

Four nozzles deliver about 650 g.p.m. at 1100 p.s.i. Considerable difficulty has been experienced with the mechanical drive of the feed rolls in that gears have failed. Water contaminates the grease in the gear cases making it necessary to drain off water and refill with grease at least once a week.

Some wood is lost through cutting and splintering.

3B. Weyerhaeuser Large Saw-log Barker (6)

This unit is arranged to receive logs on way to mill 1 at Longview sawmill and does this by kicking a log out of horizontal section of log haul, and transferring it back into log haul after barking.

The motion of log is a slow forward and rotation combined, so that barked area is a spiral which overlaps enough to secure complete bark removal.

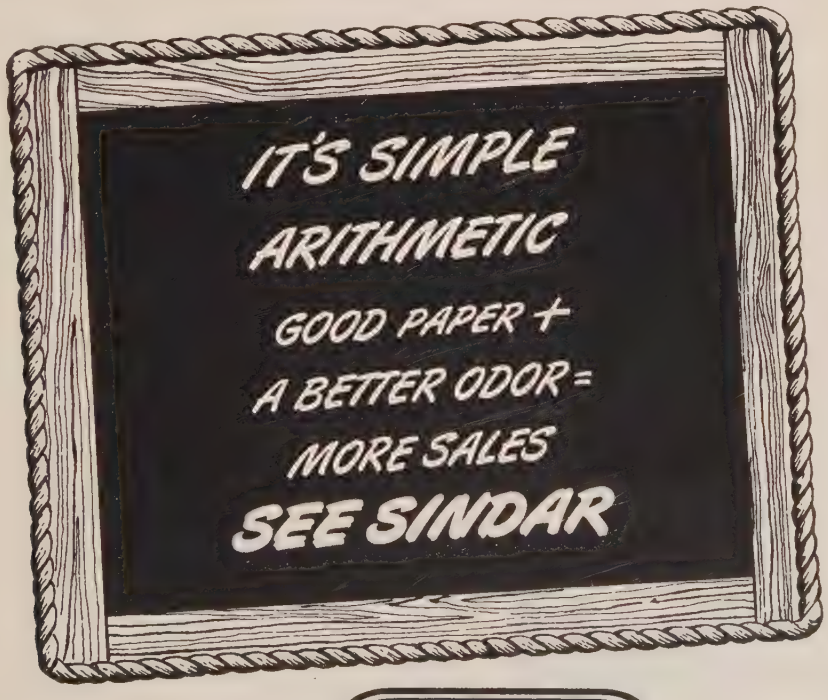
Motion is secured by supporting logs on driven rolls which can be adjusted to an angle which coincides with tangent to the desired spiral. This adjustment permits efficient use of full water sweep.

When motion is arrested by log irregularities, lift skids dislodge the interference and allow log to assume desired travel.

Nozzles, two in number, are directed from below log. They point toward axis of average size log expected in mill and have rapid angular movement in direction of log axis, one moving to left from a meeting point and back, the other moving to right and back. The barked strip is about 4 feet wide.

Barker designed to handle a 32,000-pound log at rate which corresponds to mill consumption. The pump requires 600 hp. and supplies 600 g.p.m. at 1400 p.s.i.

Except for occasional hose breakage, this barker has been very easy to maintain. The sawmill has become



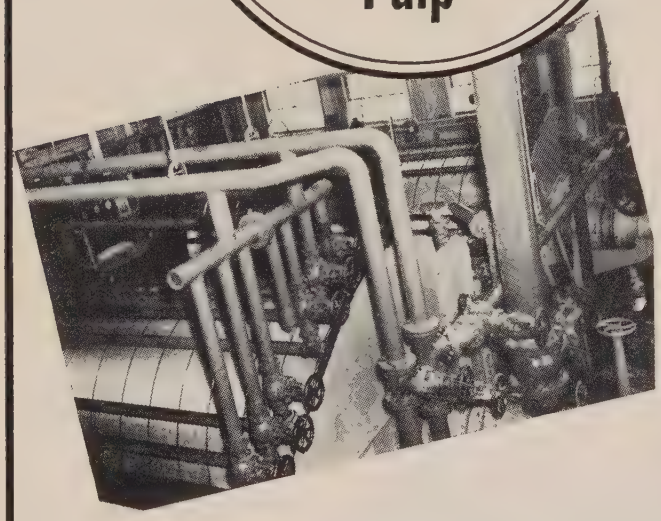
SINDAR Corporation
Industrial Aromatics and Chemicals
330 West 42nd Street • New York 18, N. Y.
Branches: Philadelphia, Boston, Cincinnati, Detroit, Chicago, Seattle, Los Angeles, Montreal, Toronto

OLIVER

"RINGVALVES"

for washing

Semi-Chemical Pulp



A BOOK could be written about the wide use of the Oliver Ringvalve Filter for washing sulphate and sulphite stock ... how its unique design and uniform sheet promote high washing efficiency ... how its flexibility permits wide variations in washing methods.

Here's a "Ringvalve" installation at Sonoco Products Company, Hartsville, S. C. where the filters are operating on semi-chemical pulp and doing a fine job ... more evidence of the versatility of the Oliver Ringvalve Washer! At present the two filters are operating as a 4-stage, series washing system. Later, when the tonnage is doubled, a third unit will be added and the system changed to 3-stage counter-current washing.

With such a fine record being made by the Oliver Ringvalve Washer in over 30 mills — a record of high washing efficiency, flexibility in operation, sustained overload or surge capacity — can you afford not to investigate fully its merits for your pulp washing requirements?

OLIVER UNITED FILTERS INC.

New York 18, N. Y.
33 West 42nd Street

Chicago 1, Ill.
221 N. LaSalle Street

Western Sales Div:
Oakland 1, Calif.
2900 Glascock Street

San Francisco 11, California

Sales & Manufacturing Representative:
E. Long Limited, Orillia, Ont., Canada

Factories:
Oakland, Calif. • Hazleton, Pa. • Orillia, Ont., Canada • Melbourne, Australia

accustomed to barked logs and complains at temporary lapses. Clean logs allow the saws to go longer between changes, improves log utilization, and allows use of slabs for pulp chips when condition of surface wood is good enough for that purpose. The sawmill is easier to keep clean. It is essentially a machine for large, long logs and does a big job with relatively little total power. One operator is required.

4A. Allis-Chalmers "Stream barker"

This barker is a packaged unit which was developed to handle wood in the size range between 4 and 21 inches diameter, and length between 5 and 10 feet. As currently used, most of the wood approximates 8 feet.

The log is cradled between two long rolls, one with spiral ridges and the other with longitudinal ridges. Each is provided with its own drive which is set to provide the proper speed of rotation and feed for the entering log.

This feed works well on relatively smooth logs between 6 and 15 inches diameter. Small logs are frequently very slow in passing through the nozzles zone. Rough logs bounce violently, or engage a projection in the spiral flutes and are whisked through the machine with only partial bark removal.

The ridges on the rolls actually do some of the cutting of the bark, and also are responsible for surface cutting and splintering of the wood. Examination of waste from this barker shows that at times there is a considerable wood loss.

When the logs are summer cut, a pressure of 700 p.s.i. will effectively remove bark from relatively smooth logs. If the bark is tight, the pressure must be increased to 1000 p.s.i., or even to 1200 p.s.i. in order to get good production. The higher pressure exerts greater retarding effect on small wood.

Small rough or crooked logs are liable to jump off the rolls and wedge in the housing. Split wood is liable to cast a large sliver which will wedge between the rolls and stall them. Limbs are liable to wedge.

Rough wood bounces so violently that it dodges the effective barking area and must be passed through several times before it is cleaned.

***5A. Weyerhaeuser Experimental at Longview* (7)**

In this unit the log is carried on a wheeled carriage running on track which is moved back and forth by a winch equipped with a variable speed drive. Arrangements were made so that the log could be indexed to present a fresh bark surface. The nozzles used varied in shape, pressure, distance from surface. The log sections were chosen for variety of bark thickness and contour. With this unit the most effective angle was found to be near 90°.

Low pressures were found not to be effective which finding has been confirmed by subsequent work at Everett on a large log barker and slab barker, and at Soundview.

Efficiency—barking greatest area with a given power use—was found to be at a maximum with comparatively high-relative motion of nozzle to log.

The great weight of large logs made the idea of rapid reciprocation past a fixed nozzle unattractive. Such an arrangement is used in saw mills, but details in hydraulic barking required different solution.

This experimental work was done at 1000 p.s.i. with 400 hp.. Approximately 550 g.p.m. were pumped through a single nozzle.

***7C. Weyerhaeuser First Whole Log Barker at Everett* (7)**

The log is loaded into the barker from a storage transfer by means of a steam cylinder-powered log loader and a set of powered skids. The entry door is raised during loading and the log is positioned over water path by adjustable

knees on exit side and skid shoes on entrance side. It is held down by toothed chains, and indexed by them at each passage of the nozzle into the end zone.

Two nozzles are held by a carriage on steel rail tracks, and supplied with water by eight hoses 35 feet long and $1^1/_2$ inches inside diameter. The nozzle carriage is moved by a cable operated by Sumner steam feed engine; approximate barking travel speed 20 ft. per sec: with an average of 14 ft. per sec., including reversing time. The hose slack is controlled by sheaves with four grooves and is held apart by cable. With a water flow of about 1000 g.p.m. at 1380 p.s.i. pressure, it takes approximately 30 seconds to bark a log.

Unloading is accomplished by arms raised by water pressure, and a fresh log is kicked in at same time.

Damage to nozzles by branches, etc., is reduced by a swivel joint.

The amount of index is controlled by barkerman, there being more movement when bark is loose. Normally, this barker working alone requires eight hours to prepare 1200 tons (chips) and runs one shift of eight hours everyday of the week. With wood for other barkers and chippers it is practicable to run the main barker six days per week unless very hard barking, small, or difficult shapes are encountered.

In regard to repair experience it is not the best of the barkers, but there is great reduction in crew and wood losses compared to previous methods. Electric power and water requirements are the same, but steam required is reduced. This barker was put in operation on Aug. 7, 1942, (173-inch chipper operation began Jan. 25, 1943).

8C. Weyerhaeuser Type—Longview and Powell River (8)

The log entry and exit much the same as at Everett with knees used to position the log. Indexing chains are moved continuously to provide a fairly steady rotation, and hold the log down against force of jets from nozzles.

The nozzle carriage slides on micarta shoes instead of rolling on wheels. The micarta was lubricated by water at first, but the splash chilled the piston rod of the shotgun too much, so oil is now used. The reciprocating motion from the shotgun cylinder gives a very rapid reversal on a steam cushion, and still is fairly economical of steam. Some difficulty was experienced with running the nozzles to the end zone and getting started again after changing logs.

At Longview a single high-pressure pump is used. At Powell River provision is made for summer pressure of 850 p.s.i. and winter pressure of 1250 p.s.i. through use of a booster pump.

It is difficult to compare the performance of a shotgun versus the steam engine since logs vary, operator skill does influence production, and pumping equipment is not the same.

The introduction of water through hose connections to and from a "wobble pipe" has given some maintenance trouble, but this may be expected to continue to improve in method as time goes on.

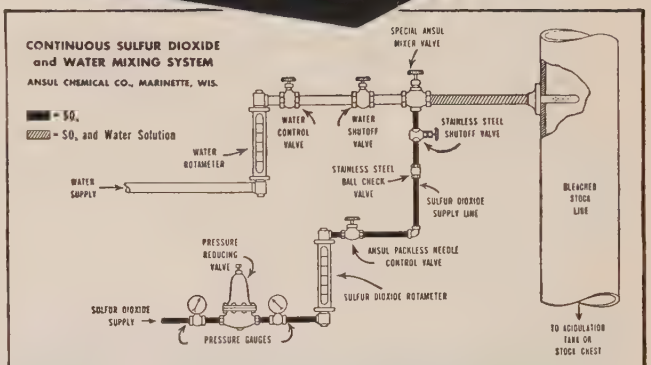
Each mill has benefited in saving manpower and wood, but here again comparison is difficult, since much of the Powell River wood is reduced in size by a sawmill to pieces suitable for manufacture of groundwood. The Longview and Powell River units began operation late in 1946.

9C. Lathe-Type—Port Townsend, Port Angeles, Hoquiam, Hawley (9, 10)

The log is checked between face plates, usually with the aid of a centering device, and the nozzle is positioned close to bark surface and moved from one end of the log to the other at a controlled rate which removes bark without skips. The nozzle, which is of the slot or multiple orifice type, was developed for a wide spread.

FOR PERMANENT MAXIMUM *Brightness* in Bleached KRAFT Pulp

. . . INSTALL AN ANSUL Constant SO_2 Concentration System . . . and get Positive Control of Acidulation



This Ansul System provides a continuous metered flow of sulfur dioxide and water solution at any desired concentration and rate of flow.

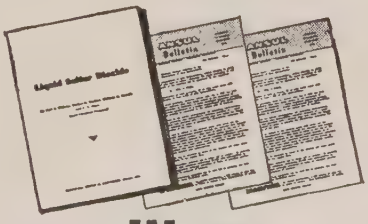
The solution may be introduced into the pulp at the acidulation tank, stock chest, the stock line from a washer, or at any suitable point in the bleaching system.

Ansul sulfur dioxide is an inexpensive acidifying agent . . . thoroughly efficient, and perfectly suited to the acidulation step in the preparation of bleached kraft pulp.

Ansul sulfur dioxide improves brightness and prevents color reversion because it:

1. Reduces colored ferric compounds to the soluble ferrous state so they may be easily washed from the pulp.
2. Bleaches and brightens the pulp by adjusting the pH to the acid side.
3. Acts as anti-chlor to remove residual chlorine and thus prevents formation of oxy-cellulose which would age to yellow compounds.
4. Permits dissolving of organic lime compounds so they may be removed by washing.

WRITE THE ANSUL TECHNICAL STAFF FOR FURTHER INFORMATION



Write today for these bulletins:
"A Method for Continually Preparing Sulfur Dioxide Solutions."
"Use of Sulfur Dioxide for Acidulation of Bleached Kraft Pulp."
Also, send for your copy of: "Liquid Sulfur Dioxide."

LIQUID Sulfur Dioxide ANSUL

ANSUL CHEMICAL COMPANY
INDUSTRIAL CHEMICALS DIVISION, MARINETTE, WISCONSIN
60 E. 42nd St., New York · Lincoln-Liberty Bldg., Broad & Chestnut Sts., Philadelphia 7, Pa.

Because the water has a relatively short travel, good use is made of power, and the pressure required is not as high as with many other types.

Difficulties are experienced in consistently obtaining as rapid a load and unload as desirable for high capacity. Also, many logs with unsound or shattered ends cannot readily be handled by this machine.

Because other types (such as the Bellingham) handle all types of wood at a high efficiency, the lathe type is not gaining new adherents and in some places is being replaced although it does show excellent results in thorough barking with good operator control. The bark seam can be given special attention, as is also possible with Bellingham-type barker.

10C. Bellingham Type of Whole Log Barker (11–14)

The log is loaded into the barking station by a log loader of a sawmill type, the unloader serving as a stop to prevent the log from going too far. The barking position in this machine is in the valley between two rows of wheels which almost touch. Each row of wheels is mounted on a suitably heavy shaft that is adequately supported on bearings.

For large logs up to 80 inches diameter, the wheels are about 48 inches in diameter. The distance between the shafts is 49½ inches. Seven wheels on each shaft are satisfactory for a machine which handles only longer logs, that is, at least 12 and up to 26 feet long.

At Bellingham the barker has been modified by addition of intermediate wheels in such location that 8-foot length farmer and salvage logs may also be handled. The important feature of the arrangement is that even rough logs can be rotated at sufficiently high speed to give good barker efficiency.

A feature which adds to the effectiveness of this barker design is that the logs are rotated without any overhead mechanism, and consequently the nozzle may be mounted overhead in full view of the operator. Provision is made for raising or lowering the nozzle so that it may clear projections from the log, or be brought close to the surface of smooth, hard barking logs. A further advantage is that the operator sees without delay the progress and quality of bark removal and may compensate as necessary by control of the various parts of the machine.

When a log, which contains a surface bark seam, is encountered it can be rolled until this defect is stationary under the stream from nozzle. Movement of the nozzle carriage then directs the stream in a very effective manner against the narrow band of almost inaccessible bark.

To some extent the Bellingham barker owes its splendid record to skillfull engineering which has eliminated high-speed parts and has built a tremendously strong plant that is adequate for the heavy duty it must perform.

Additional units of this type have been or are being installed.

The foregoing descriptions have shown that the practice of cleaning wood hydraulically has not yet settled upon one method as the best for all sizes of wood and conditions of operation. On the contrary it adapts itself admirably to special requirements, and in most installations it increases the variety of material which can be prepared for chipping at a cost which the pulp mill can afford to pay.

By far the most important contribution by hydraulic barking is its startling reduction in waste. At a time when all mills are attempting to regulate their withdrawal from the forests to a quantity that is replaceable by normal growth, the hydraulic barker has made it possible to operate with about four-fifths of the forest area which would have been required prior to its development. This is a factor that can well be vital in the survival and continued existence of mills which form important units in the life of many communities.

LITERATURE CITED

1. *Pulp Paper Ind.* 17, No. 12: 23 (Dec., 1943).
2. *Pulp Paper Ind.* 20, No. 11: 28 (Oct., 1946).
3. *Pulp Paper Ind.* 19, No. 12: 36 (Dec., 1945).
4. *Pulp Paper Ind.* 19, No. 3: 326 (Mar., 1945).
5. *Pulp Paper Ind.* 18, No. 10: 15 (Oct., 1944).
6. Weyerhaeuser Timber Co., Dept. of Public Information. Weyerhaeuser hydraulic barker for large saw logs. 1948 news release.
7. *Pulp Paper Ind.* 17, No. 5: 26 (May, 1943).
8. *Pulp Paper Ind.* 21, No. 5: 26 (May, 1947).
9. *Pulp Paper Ind.* 18, No. 2: 7 (Feb., 1944).
10. *Pulp Paper Ind.* 19, No. 9: 45 (Sept., 1945).
11. *Pulp Paper Ind.* 21, No. 10: 32 (Oct., 1947) .
12. Haner, V. C., and Rose, H. A., AIEE Tech. Paper 48-190.
13. *Link Belt News,* Bellingham barker, conveying equipment (June–July 1948).
14. *Sumner Iron Works Shop Talk,* Bellingham barker, equipment (Sept., 1947).

Received Aug. 17, 1949. Presented at the Fall Meeting of the Technical Association of the Pulp & Paper Industry held at the Multnomah Hotel Portland, Ore., Sept. 12–15, 1949.

Education and the Paper Industry

JOHN G. STRANGE

I can think of no enterprise that is more important to the future of our industry than formal education. Nor can I think of any activity that is less understood, even by people who are reasonably well informed and thoughtful on other matters.

There is, of course, general agreement on the importance of the educational system. This agreement is based, first, upon the necessity of having a literate society and, next, upon what is vaguely referred to as the necessity of an adequate background in the social values and technical skills of modern civilization. In the mind of the public at large, therefore, "education" is definitely classified as a "good thing," just as we popularly classify "democracy" as a good thing. Everyone is for "good things" and, therefore, everyone is in favor of this activity called education. It is seldom that people go beyond this in their thinking. How often, for example, do we raise questions such as: education for what? or education for whom? or, even more profoundly, education by whom? These are vital questions. They are current questions. And the field of education is deeply troubled by them.

First of all, let us consider the fact that education is just as much a business or an industry as is the manufacture of paper. It is subject to many of the same problems. It is concerned with issues of supply and demand, with costs of operation, with the specification of raw materials, with use requirements, with payrolls, with unions, and with many of the economic phenomena and emotions that confront all business. Education may discuss these things in loftier terms than we use in industry. It may use noble expressions and may take "dignified" action but, basically, there is great similarity in motivation, if not always in purpose.

In order that we may gain perspective on some of the more mundane aspects of education, it is helpful to look at the restricted field of what is called higher education. We are proud of the size and vigor of the paper industry and frequently refer to it as one of the largest national industries. It is revealing, therefore, to observe that the net worth of the pulp and paper industry in 1947 was calculated to be approximately $2,870,000,000. In this same year, the net worth of colleges and universities, as measured by the book value of land, facilities, endowments, and other

John G. Strange, Secretary-Treasurer, The Institute of Paper Chemistry, Appleton, Wis.

restricted funds, was over 5 billion dollars—almost twice as much as the value of the entire pulp and paper industry. We are proud of the rapid growth of the paper industry, a growth which has been outstanding in our economic system. We point to the fact that the net worth of the industry has increased by nearly $2,800,000,000 since 1890, whereas, in this same period the "net worth," if we may use that expression, of institutions of higher education increased by more than 4 billion dollars. Since 1945, the paper industry has probably added to its investment in facilities by approximately $700,000,000, a tremendous surge forward. Institutions of higher learning, however, have announced campaigns for endowment funds which have been estimated to total nearly 2 billion dollars. We are so accustomed to astronomical figures these days that they tend to lose their significance. Perhaps it will help, therefore, in evaluating the current endowment drives, to say that the colleges and universities are seeking funds which aggregate more than twice as much as all the assets in the 20 largest public trusts. These trusts include such well-known endowments as the various Carnegie Foundations, the Rockefeller Foundation, the Guggenheim Foundations, the Kresge Foundation, the Ford Foundation, and various other great philanthropic institutions. The college endowment campaigns, mind you, do not include separate and long-range projects for buildings and equipment which some of the more conservative mathematicians have estimated at over 5 billion dollars.

You may ask why it is necessary for higher education to seek such vast resources—resources which are considerably greater than the accumulative philanthropies and bequests for these same purposes since the beginning of our national history. It is important and, more than that, it is incumbent on all of us to ask this question, since obviously financial needs are based upon certain assumptions with respect to educational trends and educational philosophies.

First of all, let us inquire into the growth in college population. Back in 1890, 14,306 men and women graduated from college. In 1940, 186,500 men and women obtained bachelor's degrees, an increase of thirteen-fold. Naturally, the population of our country also increased significantly in this span of years. Nevertheless, in 1890, only slightly over 1% of those 21 years of age graduated from college. In 1940, this figure had risen to roughly 7%. Thus, after taking into account population growth, higher education increased its production rate nearly seven-fold. We see, then, that one of the factors requiring new resources is the increasing demand for advanced education.

More important, however, than increased attendance, especially within the past several years, is the burden imposed upon institutional financing by the cheaper dollar. A large educational plant is, in reality, a large business enterprise. It is directly and immediately affected by increased costs of operation. The average opinion seems to be that the inflation of the past three years has increased the operating costs of colleges and universities by over 50%. I believe this to be an accurate estimation, because in the case of my own institution the figure is somewhere between 50 and 55%. Concurrent with these higher institutional costs of living has been the necessity of increasing salaries. These increases have been quite modest in proportion to the times and yet they have added further to the financial load.

Private institutions have been particularly affected by costs of operation and even schools with wealthy endowments have found that the return on their investments is providing a constantly decreasing portion of the over-all budget. One survey has disclosed that 32% of the operating budgets of 59 institutions came from endowment in 1936, whereas in 1946 only 24% of their budgets were so provided. The experience of these selected schools is decidedly more

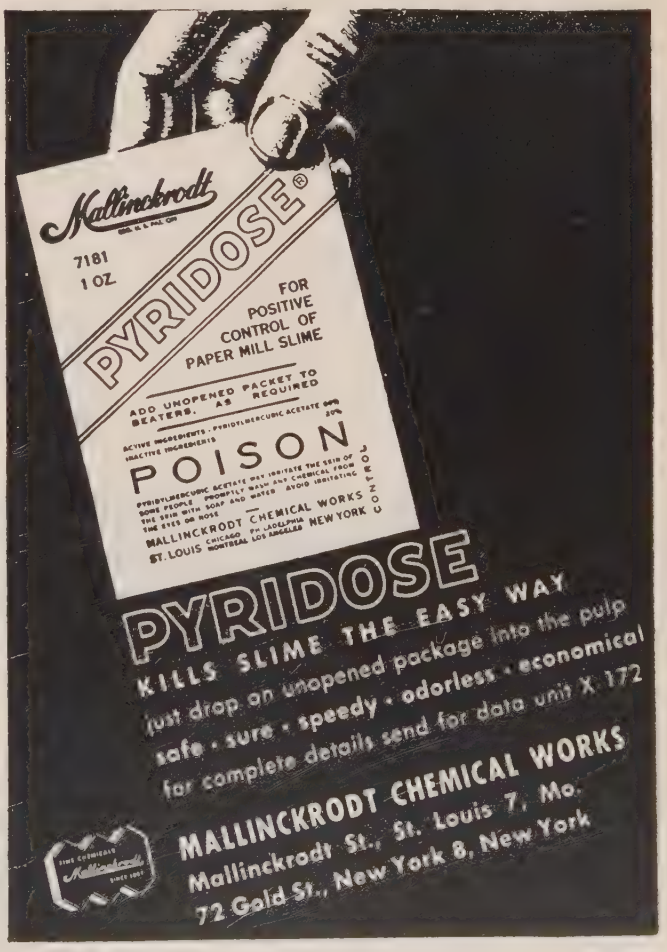
Photo, Courtesy J. M. Huber Corporation

Single Instrument Measures Smoothness, Porosity and Softness of Paper

You just interchange the lower test plates in the GURLEY-HILL S-P-S Tester to convert it into an instrument for testing either smoothness, porosity or softness of any type of paper, by measuring a given air-leakage over or through the paper.

This 3 in 1 laboratory "assistant" is simple to operate, quick and accurate, and a real utility instrument where printing quality of paper must be reliably measured.

Bulletin No. 1400 describes the S-P-S Tester as well as other Gurley paper testing instruments. It's worth writing for today. W. & L. E. Gurley, Station Plaza & Fulton Sts., Troy, New York.


Mallinckrodt
7181
1 OZ
PYRIDOSE®
FOR POSITIVE CONTROL OF PAPER MILL SLIME
ADD UNOPENED PACKET TO BEATERS. AS REQUIRED
POISON
MALLINCKRODT CHEMICAL WORKS
ST. LOUIS NEW YORK
PYRIDOSE
KILLS SLIME THE EASY WAY
just drop an unopened package into the pulp
safe • sure • speedy • odorless • economical
for complete details send for data unit X 172
MALLINCKRODT CHEMICAL WORKS
Mallinckrodt St., St. Louis 7, Mo.
72 Gold St., New York 8, New York

favorable, incidentally, than that of schools in general. Various steps have been taken to balance this situation. Student fees have been raised, not only once but several times by many institutions. Gifts for current operation have been sought from alumni and from the surrounding communities. There is a limit, however, to the amount which may be expected from these other sources. It is plain, for example, that the increased student fees would not have been possible except for the GI Bill of Rights. Few people realize that through the GI Bill of Rights colleges have enjoyed an income during the past three years of nearly 1 billion dollars.

Publicly supported colleges and universities have had their own very serious budgetary problems. These problems find their origin in the same trends that have affected private schools, the two paramount trends being increased enrollment and rising operating costs. Inasmuch as the funds for the operation of public institutions come primarily from the annual appropriations of legislative bodies, these institutions by and large have had less trouble in balancing their situation than the private schools which have to depend so substantially on voluntary bequests. This leads to a further point which we might consider before leaving the financial side of higher education.

COMMISSION ON EDUCATION

Many of you are undoubtedly familiar with the fact that the President appointed a commission back in 1946 for the purpose of studying our system of higher education and making recommendations with respect to future action. I suspect that very few of you have had an opportunity to review the several reports which have been issued as a result of the commission's study.

Without going into the social and philosophical conclusions of this commission, many of which are, to say the least, extremely debatable, let us summarize briefly their recommendations. First of all, the commission concludes that in 1960 there should be a minimum of 4,600,000 young people enrolled in higher education. This, incidentally, is more than 3 million greater than the top prewar enrollment. The commission further concludes that the annual cost of handling this enrollment will be $2,587,000,000 or almost five times the highest prewar expenditure. Having reached these conclusions, the commission then takes the position that the various endowment drives and building programs of the privately supported schools will merely enable those institutions to handle adequately the financial and educational burdens imposed by the enrollments in those schools during the academic year 1946–1947. Additional enrollments apparently are to be taken care of by public institutions. As a means of augmenting the support of local and state governments for the new responsibilities of these public institutions, the commission recommends that the Federal Government appropriate funds for undergraduate scholarships at an initial annual outlay of $120,000,000, this outlay to increase in an amount sufficient to provide Federal scholarships for 20% of the total college population. The commission also recommends that the Federal Government appropriate at least $45,000,000 a year for graduate fellowships. The undergraduate scholarships are to be awarded on the basis of "need," whereas graduate fellowships are to be awarded on the basis of competitive examination. In either event, the students are to be free to choose their own college or university, whether it be privately or publicly supported.

In addition to its scholarship and fellowship program, the commission next recommends that the Federal Government appropriate aid for the current operating expense of public institutions, starting with $53,000,000 and increasing annually to the sum of $267,000,000 by 1952. To help in the building programs of these same institutions, the commission recommends that the Federal Government appropriate $216,000,000 a year for the next five years. Please note that the Federal appropriations for operating expense and building funds are expressly restricted to public schools.

It is hard to follow figures when they are presented orally. For your convenience, therefore, all this may be summarized by saying that the commission anticipates annual Federal appropriations for higher education alone in the amount of 1 billion dollars a year by 1960. You will recall that it is in this same year that the commission feels there should, and I would like to emphasize the commission's choice of the word *should,* be an enrollment in colleges of at least 4,600,000. These expenditures are quite independent of separate recommendations made by the President's Scientific Research Board, which has advocated annual Federal appropriations of at least one-quarter of a billion dollars for basic research in universities and colleges by the year 1957.

I hope that I have not tried your patience unduly in reciting some of the recent history and ideas with respect to the costs and enrollments of higher education. It seemed appropriate to go into this detail, however, in order that better perspective might be gained on the very basic question raised in the beginning of this discussion, namely, "education by whom?" Implicit in the answer to this question of "education by whom" is the whole issue of the purposes of education, the nature of instruction, the freedom of instruction or, in a word, the entire "climate" of our educational system.

EDUCATION FOR THE PAPER INDUSTRY

Our considerations thus far may seem quite remote from the subject of education for the paper industry. One cannot, however, give adequate thought to the needs and

requirements of our own industry without some background on the larger problem. These are days of expansive and, one might say, expensive ideas with respect to social movements and social institutions. Increasingly we hear reference to what is called the "welfare state." To many it is an appealing and humanitarian concept that we should all be groomed to the peak of our intellectual capacity, that all of our aches and pains should be freely and promptly attended, that our autumnal days should be free from economic worry and filled with pleasant occupation and that we lead happy, healthy, and intelligent lives. How pleasant these goals are and how superficially plausible they seem when taken one by one. A dilemma arises, however, when we add their costs together. This dilemma is not only a financial one but, more basically, it is a dilemma caused by the suggestion that these good things are automatically due or imposed on each of us, rather than things that should be earned or sought.

Turning now to education as it relates to the paper industry, it seems to me that we can accept without debate the statement that our industry has a continuing and expanding need for properly educated personnel. The complicated and highly sensitive character of modern society, along with the advancement of technical frontiers, require greater quantities of specialized manpower. These requirements exist not only in the production and technical areas of the industry, but in the other fields of finance, accounting, distribution, personnel, and so forth. The most logical source for this manpower is our educational structure. That is not to say that education can do the entire job. There will always be need for orientation and training on the ground, but the fundamentals and basic knowledge must be acquired, in the main, before employment.

Here we are, then, with at least three forces or trends at work. There is, first, an educational system which is striving to handle the physical and financial problems imposed by a growing college population and rising costs. There is, second, a group, and apparently an expanding one, which believes that higher education should be substantially underwritten by Federal funds and the university doors opened to all who seek them. And there is, thirdly, a growing need on the part of industry and the professions for properly trained men and women.

Is there, or should there be, any connection between these trends? Specifically speaking, should industry—our industry—concern itself actively with the movements that are taking place in the educational world? Or should we take a passive viewpoint, merely drawing upon the product of education as it becomes available? It seems to me that the only answer to this question is that it is absolutely necessary for industry to play an active part in the educational world, to improve and extend considerably its connections in that field, not only for industry's benefit, but also for the wholesome influence that such a relationship might have on the future of education itself. Many business concerns, of course, have made it a practice to visit certain schools and this practice seems to be spreading. This, however, is not enough. There are several further things that might be done, and I should like to mention a few of them.

1. It is not sufficient for personnel officers merely to go on scouting expeditions among graduating classes for promising new employees. A further effort should be made to acquant pertinent faculty members and students, in general, with the nature of our industry, its needs and its use requirements. In this way, both teachers and students gain a clearer conception of what the industry is seeking and knowledge of the opportunities which exist is not then confined to those who, by accident of geography or contact, may have become interested in our area of the economy. There is room for a real job of public relations to be done in this field. A program along these lines would indeed be a far cry from the viewpoint expressed not so many years ago by the personnel officer of a very large corporation, who said that he was not a bit interested in what his industry had to offer the graduate; his interest was confined to what the graduate had to offer his company!

2. Industry should continuously caution the educational world against the danger of too much specialization at the undergraduate level. It may seem paradoxical to suggest that industry do this, since one would assume education's normal inclinations would be in the opposite direction. Unfortunately, this is not always the case, and by taking a positive position, industry can make a tremendous contribution to the substance and significance of future educational movements. As a society, we must never lose sight of the importance of an adequate general grounding in the arts and sciences, because it is through these disciplines that our young men and women may gain an insight into those things and the heritage which we have in common. Later on, as we specialize or as we enter a given occupation, our time and thought are largely absorbed in problems which are more concerned with the particular than with the general. And, yet it is the general that knits us together and ultimately dictates our social and political environments. It is the general that provides us with a sense of values and the basis for developing a common outlook and a common goal.

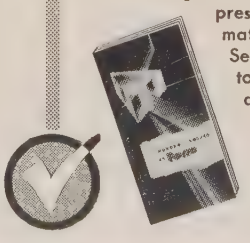
3. Whenever possible, industry should assist the scholarship and graduate research programs of appropriate colleges and universities. Many concerns are doing this. The practice, however, should be considerably more widespread. Rewards are both short and long range. In this regard, it is pertinent to quote from a recent article by Robert West Howard, who says:

Need fresh INORGANIC colors?

Check these FERRO Advantages Against your Present Pigments . . .

- All Colors Stable to 1500°F—some to 2300°F
- Will Not Change Shade Under Heat and Pressure
- Available in Paste or Easy to Grind Powder Form
- Blend Exceptionally Well With Raw Materials
- Suspend Well in Water Solutions
- Not Affected by Acids and Alkalies

A Few Industries Ferro Formulates Colorants For:
Ink Mfgers. • Paints • Plastics • Paper Goods • Textiles • Rubber Goods



Send for this FREE booklet on Ferro Inorganic Colors. Just off the press it gives information on the Ferro Services available to users of colorants. Write today! Ferro Enamel Corp., Dept. 10, 4150 E. 56th St., Cleveland 5, Ohio.

"In 1949, more than 2000 students . . . are going to college as guests of our industries. Less than half of them will take employment, after graduation, with the firms who give them this opportunity . . . Yet the array of scholarships, fellowships and grants costs the donors upwards of $10,000,000 a year."

4. Industry should establish a closer relationship with the work that is going forward in graduate schools. It is in this area of education that there is the greatest opportunity for specialization and for specific orientation to future careers. Here the student has, or presumably has, already acquired a good start toward a fundamental background. He is more mature in his outlook and more certain of his fields of interest. Here also lies an opportunity for research on some of the basic problems of industry. It is in this field of graduate education that there appears to be perhaps the greatest opportunity of all for close cooperation and, perhaps, even affiliation of education and industry. It is in this field that The Institute of Paper Chemistry is pioneering.

There is a certain thrill, a certain satisfaction, that comes from belonging to a pioneering organization, and most of those who are associated with The Institute of Paper Chemistry are conscious of this spirit. Please do not interpret what I have just said as an indication of institutional conceit. We are aware of shortcomings and we also have a profound respect for the work which is going forward at other educational and scientific enterprises. We do not, in other words, feel that we are exclusively good or exclusively right. We are persuaded, nevertheless, that there is a profound educational significance in the program of the Institute, a significance which transcends our own area of activity.

Bearing in mind some of the educational dilemmas covered earlier in this discussion, let us inquire briefly into a few features of the Institute's program.

The Institute is, first of all, a graduate school. Its purpose is to prepare a carefully selected and limited number of young men for careers in the pulp and paper industry. It is supported by those who take its product. It is engaged actively in research in the various fields covered by its curriculum. Scholarships are awarded to all who attend its courses. It is, in other words, an educational community where there is a common purpose among staff and students, where the cost of the program is provided by those who will enjoy its results, where admission is determined by ability and attitude rather than by financial means, and where there is a cohesiveness of objective.

There is little that is vocational about the program of the Institute. Its curriculum is concerned fundamentally and profoundly with various fields of science. The requirements for a satisfactory thesis are, if anything, more rigid than in most graduate schools. Generally, the program is concerned with the development of scientific understanding and with the creation of a viewpoint. Its goal, as stated on previous occasions, is to "build on top of fundamental knowledge gained in the university, advancing even closer to scientific frontiers and weaving into the program the technology of our own industry." The broad objective is to "produce students with the ability to relate the processes and problems of this industry to science in general, thereby helping to translate our tremendous backlog of experience and empiricism to a more thorough understanding of the many mysteries that surround papermaking and related fields from beginning to end."

In one sense, the program of the Institute recognizes a new profession. For many years the layman has been accustomed to think of medicine, law, and teaching, for example, as fields involving a special type of graduate education and a special level of professional competence. The advancement of technology, the expanded frontiers and complications of science, and the specialization of industrial processes have, we believe, led to the need for recognition of what might be called the profession of the "industrial scientist." The Institute of Paper Chemistry is one of the earliest articulations of this profession. Educationally, this concept is relatively new and yet we are convinced that it will endure and expand in the years ahead.

If there were time I would like to cover more completely several other aspects of the Institute's educational activities. Yet it seems to me that sufficient has been said to indicate that we have in this industry a very interesting and significant approach to some of the fundamental issues that are confronting advanced education. We have here some rather satisfactory answers, at least within the area of graduate education, to the questions of education for what? and education for whom? and by whom? I submit that these answers are infinitely better and more promising than any approach which is based primarily upon Federal aid or Federal subsidy.

In anticipation of giving this paper, it was suggested that I refer to some of the principal problems involved in operating an educational institution of our type. Well, there are many problems and, like most problems, they are never completely solved. There are problems involving students; there are problems involving staff; there are problems involving the industry. We have our financial "headaches." We have our struggles with "public relations" and yet, if I were to pick the single, most enduring, and most difficult problem of all, it would be that of selecting our student body.

Each year our educational officers visit approximately 80 different colleges and universities throughout the country. During this odyssey, they talk with professors and interview young men who either have manifested or might manifest an interest in coming to the Institute. Our maximum for the entering class is 16. The problem, therefore, is to narrow the field to this number, selecting those who seem to be the most promising, not only in terms of their ability to profit by our academic program but also in terms of their subsequent ability to survive and grow within the industry after graduation.

Graduate instruction is always expensive. Our type of program, with its high faculty-student ratio, is especially so. Thus, on purely economic grounds, student mortality should be held to a minimum. More important, however, is the fact that there is a steady demand for Institute graduates and any disproportionate loss of students is disappointing in the face of that demand. In spite of the investment which we may make in a student and in spite of the steady need for graduates on the part of the industry, it is imperative that we maintain our educational standards. These considerations, therefore, cannot and do not interfere with the dropping of students who are not performing adequately. The key to our mortality problem, therefore, as well as the key to the success of our graduates, lies in the effectiveness of our original selections.

It is relatively simple to screen applicants initially on the basis of their undergraduate performance and on the basis of the soundness and completeness of the courses which they may have taken. Insight can also be gained into some of their personality traits and their capacity for leadership as demonstrated in various school activities. The observations of their professors, in many instances, are also illuminating. In general, however, these yardsticks are not adequate to predict the creative talent of the candidate, nor are they adequate to anticipate his emotional and intellectual capacity to weather the various situations which will be encountered, first at the Institute and later in industry. In recent years, a great deal has been done and considerable progress has been made in personnel testing as a means of predicting more closely some of these imponderables.

Our own staff has been actively concerned, not only with existing techniques in this field, but we have also pioneered in new test methods. All this notwithstanding, there are still unknowns. These unknowns exist not only because any human being is a bundle of contradictions but also because of the unpredictable combinations of environments and circumstances which may be met in later life.

Inasmuch as the Institute has such a close relationship with the industry which first supports and then employs its students, we have an infinitely greater and more easily traced accountability than does the normal graduate school. Our job, in short, is not only to select students who will do well when they are with us but, beyond this, it is to select students who will do well after they have left us. I believe that enough has been said about the general subject of student selection to make it clear that this is the most difficult and most important single problem involved in our educational activities. One way of pointing up this subject is to observe that when a paper mill makes some poor paper it can simply route it back to the broke pile, whereas when the Institute turns out a graduate who subsequently flounders, his record will haunt us as long as he lives.

In closing, I should like to return to the original educational scene. It is hard to conceive of anything that has a greater bearing on you and me—on all of us—than the future of the American school system. For it is in this system that our corporate mental and physical health is nourished. It is here that attitudes are formed and ideas and ideals are embraced or discarded. Reflection will show that schools, especially primary and secondary schools, offer the only common experience that we have. We come from different homes, we are reared in different faiths, we are engaged in different pursuits, and we practice our particular skills—we specialize all along the line. It is, therefore, only during those brief years of general education that we are living and working together and learning in a common environment. Schools are, in reality, the guardians of society. Run in one way they nourish democracy. Run in another way, they may nourish, equally well, totalitarianism.

It is imperative that we all concern ourselves actively and continuously with this enterprise of education from its most elementary form to the top of its hierarchy.

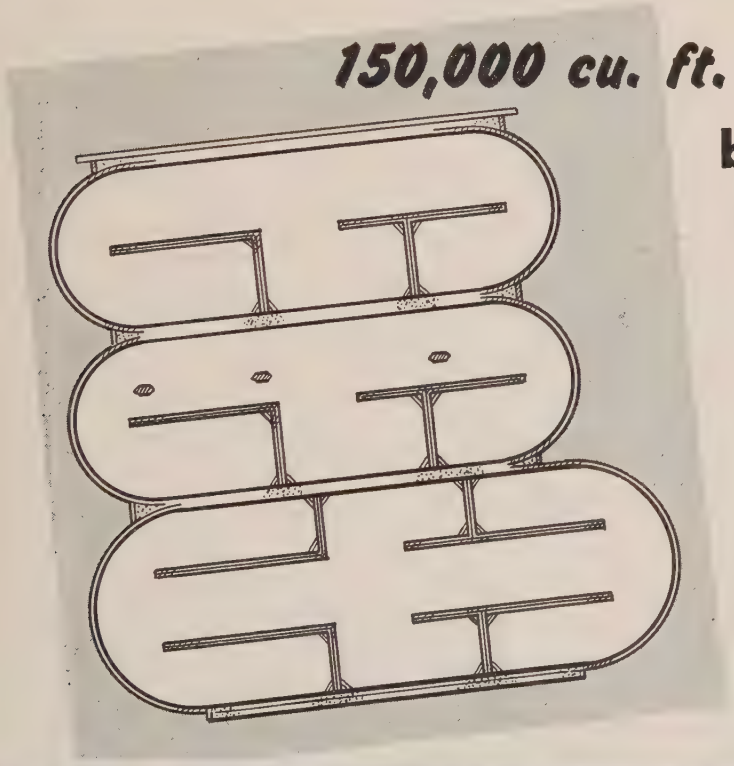
Presented at the Fall Meeting of the Technical Association of the Pulp & Paper Industry held at the Multnomah Hotel, Portland, Ore., Sept. 12–15, 1949.

The Beater Addition Process for Producing Laminating Papers

FRANCIS H. SNYDER, L. SPIWAK, and ALFRED E. MOYER

THE POSSIBILITY of incorporating phenolic resins during papermaking has, for a considerable time, intrigued paper chemists. This interesting work has mainly concerned itself with elimination of the added expense involved in standard off-machine impregnating practice. However, because of the nature of the resins employed, it was impossible to realize even this single advantage on fourdrinier and cylinder machines operating with open or partially open white-water systems. The primary reasons for failure were: poor resin retention, reduction of freeness, bulky handling methods, complicated performance on conventional equipment, large volumes of unreclaimable broke, and high resin costs. All of these factors and others combined to give low yields of materials which were excessively costly. Moreover, these materials, in most cases, did not indicate any unusual properties which might warrant continuance of their production.

FRANCIS H. SNYDER, President; L. SPIWAK, Manager Technical Service and Development; and A. E. MOYER, Assistant to President, Snyder Chemical Corp., Bethel, Conn.



150,000 cu. ft. of Storage Space built by STEBBINS for Slush Pulp System

THE three Semtile chests shown in plan will provide absolutely clean storage for three kinds of pulp in slush form, ready for pumping to the beaters or stock preparation system. When you have decided on your chest requirements for any stock handling or storage system, consult Stebbins to obtain the best possible construction for long time dependable service.

SEMCO

Stebbins Engineering and Manufacturing Company

EASTERN BOULEVARD, WATERTOWN, NEW YORK

During the preceding year, a new series of phenolic resins for beater addition were introduced. These resins not only have eliminated the deficiencies of the older materials but also have promoted the development of new, improved types of paper base laminates as compared with those with which we have been familiar in the past. These resins definitely bridge the gap that exists between water-soluble and alcohol-soluble resin types. This has been brought about by control of molecular size and structure in such a manner that the resin bodies are completely water insoluble. However, in order to function in an aqueous system, the resins are designed to disperse freely in from 50 to 350% of water before precipitation occurs. When the latter takes place, it is always in the form of a stable emulsion of extremely fine particle size.

The procedure for adding the resins to pulp stocks is simple and may be outlined by the following steps:

1. Adjust the temperature and pH of the prepared pulp stock in the beater to the proper levels. This procedure is not too critical, a fairly wide latitude being allowable.
2. Organic and inorganic pigment colors, dyes, fillers, rubber latices, and other modifiers are generally added prior to the resin unless indicated otherwise for special effects.
3. The required amount of resin which has been previously diluted with about equal its liquid volume of warm water is added, and the stock circulated with the roll lifted until dispersion is complete. This procedure depends upon rate of circulation and usually takes place within 5 to 10 minutes under normal conditions.
4. At this point the dispersed resin has formed a stable, milky emulsion throughout the stock. It is then precipitated onto the fibers by the addition of a specified acidic precipitant. Deposition of the resin onto the fibers is almost instantaneous. This is indicated by the rapid clearing of the water phase, a phenomenon which is especially impressive when using dyes, pigments, rubber latices, or other modifiers in the furnish, since these are quantitatively co-precipitated along with the resin. Further, very short fibers, or fines, also become firmly attached so that essentially none pass through the machine wire. This usually increases the over-all yield to 94 to 98%. A further effect which derives from attachment of fines to the larger masses is a slight increase in the freeness of the stock. To give an exemplary case, some stocks beaten to a freeness value of 400 (Canadian standard) prior to the addition of 50% resin and 5% latex, gave a freeness of 470 after the resin-rubber complex was precipitated onto the fibers. In this example, correction was applied on the basis of fiber weight in order to correlate the given values.

The mechanism whereby the resin is deposited on the fiber is considered to be as follows: the resin, as already noted, forms a colloidal emulsion of milky appearance upon addition to the beater. The particle size of the emulsion is such that it cannot be observed through ordinary microscopy. Upon the addition of the acidic precipitant, the emulsion "breaks" and the resin is adsorbed onto the fiber surfaces in the form of minute droplets of microscopic size. Under optimum thermal conditions, these droplets coalesce to form a continuous film, coating each fiber. The fact that this effect takes place even at very low resin concentrations is obviously important. When water surrounding the fibers is removed on the paper machine, and the sheet dried, the fibers become resin bonded. The usual hydrocellulose bonds existing in paper made in the conventional manner are replaced by resin bonds in the new papers. These resin bonds are rendered essentially indestructible as the resin becomes advanced to its finally cured state. Under the influence of heating, fusion and further condensation of the resin takes place between adjacent fibers and with reactive groups upon the fibers themselves. Off-machine resin saturation of papers results in coating the fibers, but the hydrocellulose fiber to fiber bond is not altered by the latter treatment.

As might be expected from the fundamental difference in physical structure of papers made by two different methods, the physical properties of the two types of paper are entirely different. These divergences of physical properties are shown in various physical tests performed in the wet and dry conditions, porosity tests, chemical resistance, etc. This discussion will be confined only to differences manifest during molding or existing in the physical properties of the molded laminates. When laminating papers saturated off the machine are molded, resin flows away from the fibers to fill voids between fibers, resulting in a dense structure. In the latter case, flow of fibers does not occur without rupture of the sheet. Since direct contact between fibers in beater addition resin papers does not exist due to the resin interface, the individual fibers are free to slip past each other, and the sheet is actually reformed during molding. Thus, resin separation in moldings is not in evidence, and deep draws are possible which do not contain weak sections due to lack of filler. In confirmation of this, there is little free-resin flash present, whereas a considerable amount of such flash may be observed for laminates molded from off-machine saturated papers. Further, appearance is improved since wrinkles and folds of the sheet are eliminated by its reforming.

PROPERTIES OF LAMINATES

Postforming operations on flat laminates from beater addition papers are also very successful. This is due in part to the ability of fiber to reorient, and in part, to greater toughness of this type of molding stock. The toughness is related to the fact that in the beater-treated sheet the fiber exists in a discontinuous phase, whereas in the off-machine impregnated papers both fiber and resin phases are continuous. This permits formation of cleavage planes much more readily in the latter case. Improved toughness is indicated by increased flexural strength, impact strength, machinability, and cold punchability. These resins are now available in both mechanical and electrical grades. The power factor of the latter type at 60 cycles is 0.8% at 25°C. and 0.9% at 100°C. Moldings prepared from a furnish of this resin and an equal weight of kraft pulp, had a 60-cycle power factor of 1.5 and 5.8% at 25 and 100°C., respectively. The impact strength of this laminate for a notched Izod specimen measured 2.1 foot-pounds per inch of notch.

More recently, a light-colored type has been developed which has good light and color stability, hardness intermediate between standard phenolics and melamines, and excellent abrasion and solvent-resistance permitting its use in decorative laminates. This type is also available in varnish form for off-machine saturation. The advantages inherent in an all-phenolic laminate construction are many. They include a high degree of dimensional stability, uniform expansion and shrinkage characteristics, freedom from crazing upon aging, improved impact and flexural values, reduced cost due to substitution of cheaper resins for the printed liner and overlay, and elimination of the nuisance expense of adding a "balancing" sheet. Also, because of the improved physical properties of all-phenolic construction, the laminate thickness may be correspondingly reduced, which results in laminates which can be cut with ordinary shears, bent without cracking around the radius of a lead pencil, and have excellent nailability. These materials compare most favorably with melamine surfaced laminates with respect to abrasion resistance.

Another important aspect which results in considerable reduction in operating costs, is the increased caliper of beater-addition stocks which may be run on the machine because of the faster drainage of stock on the wires, and more rapid drying. Not only is this advantageous to the papermaker, but the laminator as well profits since fewer sheets need be handled in the lay-up.

The fundamental difference in physical structure of beater-added resin papers not only results in significant improvements in the physical properties of conventional laminate constructions, but further has led to the development of entirely new laminate-construction products and materials.

The compatibility of these resins with synthetic elastomers such as Hycar, Neoprene, the various GR-S types, and vinyl

polymers, permits the co-precipitation of the elastomer emulsions with the phenolic resins. As a result, laminates of extremely high impact strength and elongation are obtainable, which can be readily cold punched in thicknesses of 0.1 inch. Natural rubber latices may likewise be employed in co-precipitations.

Two new materials have been especially developed to meet the demand for low-cost core stocks for decorative laminates without sacrificing quality. At a cost of $90 to 110 per ton of product, it is now possible to add sufficient resin to hardboard pulps in order to transform the finished board into a dense, resin-bonded molding, having a 24-hour water absorption test value of less than 4%. The increase in cost of the board, however, is somewhat smaller than apparently indicated since the increase in drainage rate of stock caused by the addition of resin will result in increased production capacity both on the board machine and the molding press. Also, loss of fines is reduced resulting in increased fiber yield. No change in the equipment or processing of the hardboard is involved. The boards are pressed wet in the usual manner. Such a single board, in addition to being less costly than the usual resin impregnated kraft, is more easily handled by the laminator since a single thickness will replace the many laminae usually present in core lay ups.

A second type of low-cost stock which has been developed contains a high percentage of pulverized redwood-plastic pulp, a fiber produced by the Pacific Lumber Co. by caustic treatment of pulverized redwood waste. This fiber has, of itself, plastic properties. A considerable amount of research on this material has been accomplished by the Institute of Paper Chemistry, and during the recent war, it was used to some extent as a replacement for phenolic molding compounds. By the addition of 15% of resin to this fiber in the beater, molding compounds have been produced which have rapid cure, excellent finish, toughness, and adequate flow. The 24-hour water absorption as measured by ASTM Method D-570 is 2.0%. Although the length of the fiber and formation properties do not permit the use of this fiber alone in the furnish for running on fourdrinier and cylinder-type machines, it handles well on the wet machine. By adding approximately 25% of a longer fiber, such as kraft, it is expected that the web shall have more than sufficient strength for continuous type machines. The estimated materials cost of such a furnish, including resin, is approximately $160 per ton. Such a material will have adequate flow for flat laminating at pressures of 600 p.s.i., and in addition, should be excellent for producing large moldings such as cafeteria trays and the like.

Overlay tissue and printed liner stocks are generally run at comparatively slow treater speeds during impregnation because of the low strength of the web in the wet state. By the addition of from 2 to 6% of the resin in the beater, wet strength of the sheet will be increased from 400 to 1000%. Considerably faster impregnation rates are thus possible. This is of particular interest to converters who purchase papers for subsequent impregnation in their plants.

A new type of backing sheet for decorative laminates has been developed which eliminates the necessity of sanding before gluing of the laminate to wood, transite, and hardboards. The backing sheet is very similar in furnish and manufacture to certain filter papers made by means of a furnish containing approximately 32% resin, 3% elastomer, and 65% kraft. The resin and elastomer are added and precipitated in the usual manner, then run onto the paper machine at maximum drier temperature. Light calendering is applied. The sheet is cured without the application of pressure for optimum results. Among other ways, curing is accomplished in 1 minute at 350°F. and can be performed on a Yankee drier or by passing the stock through a heated tower or slot heater. Such low-density papers, cured without pressure, have considerable resistance to compression. The backing sheet will bond, without additional adhesive, to the uncured core stock during the pressing of the plastic laminate, and will subsequently glue well to the laminate base. The fact that the cured backing sheet is tough and flexible rather than brittle is of extreme importance.

FAST WAY TO CLEAN

Drying Roll Frames

LONG-NEGLECTED gear-side and frames of drying roller section of papermaking machine may be cleaned quickly and safely this economical Oakite way:

Use the Oakite Sprayer, Model No. 374, with union-type nozzle, to apply full-strength solution of fast-acting Oakite Renovator. Spray solution over all exposed surfaces, allow to soak, then apply a hot-water pressure hose rinse. Oil, grease and dirt are thoroughly removed. Other time-saving procedures in 28-page Oakite Papermill Booklet. Write for it TODAY. Free without obligation.

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

TRADE MARK REG. U.S. PAT. OFF.

MATERIALS • METHODS • SERVICE

OAKITE PRODUCTS, INC., 68 Thames St., NEW YORK 6, N. Y.

Technical Service Representatives in Principal Cities of U. S. & Canada

There has been considerable recent tendency for laminators to use ordinary or treated hardboards as backings for their decorative laminates. Unfortunately, the swelling characteristics of these boards are widely different from the laminates, and the resulting structure eventually fails on exposure to high humidity. The failure almost always occurs within the hardboard, near the surface of the glue line. The addition of relatively small amounts of Synco 721 (1 to 5%) and synthetic rubber latices such as Neoprene, Hycar, GR-S IV (1 to 2%) to the fiber in the beater, improves the fiber to fiber bonding and reduces by approximately 25 to 50% (depending on input), the equilibrium moisture content of the hardboard at a relative humidity of 90%. Naturally, the resulting product is much more stable, and the tendency for failure in the board is greatly reduced. As typical of the results which may be expected, data are presented in Table I for effect of resin addition on modulus of rupture and water absorption for hardboards prepared from sulphite screenings, formerly rejected as waste in a large eastern mill.

Asbestos laminating papers and molding stocks which will mold at pressures as low as 50 p.s.i. have been developed. There is no difficulty in incorporating as much as 55 to 60% resin into the asbestos-resin furnish and running on the paper

Table I. Effect of a Resin on Physical Properties of Hardboard, from Sulphite Screenings

Resin, %	*Modulus of rupture, p.s.i.*	*Water absorption—24 hours, %*
0	4090	72
1	5540	53
3	7230	49
5	7490	49
10	8500	41

Table II. Tensile Tests on Honey-comb Core Stocks

Type of resin treatment	Resin, %	Tensile strength, lb. Dry	Wet	After folding, dry
Untreated	0	45.1	3.2	...
Water-soluble phenolic	12	54.4	27.6	36.9
Water-soluble phenolic	20	60.4	33.3	25.7
Beater-addition phenolic	12	74.2	42.2	74.5
Beater-addition phenolic	20	81.0	53.4	68.0

machine. Such materials are being investigated for use in chemical equipment, electrical insulation, and as friction materials. The technique for the addition of resin is similar to that used with cellulosic fibers except that the final pH is adjusted to approximately 7.0. The simplicity of the operation should broaden considerably the market for resin-bonded asbestos laminates since the cost of producing stocks for this purpose is considerably reduced.

A number of improvements have been made in stocks for low-density core laminates. Included among these are masking papers which may be bonded to single veneers for such purposes as skins in sandwich-type laminates employing paper honeycomb cores. These papers have superior masking and weathering qualities; further, since they do not place high shrinkage stresses on the veneers or plywood to which they are bonded, panels are produced which are completely stable and have no tendency to delaminate for this reason. These papers are supplied with a glue line and thus are self-bonding. Another major improvement in this field are papers for use in honeycomb cores. The data in Table II were obtained from machine runs of honeycomb-core papers prepared using identical pulps, but in one case the stock was off-machine saturated with a typical water-soluble phenolic resin, while in the other case, resin was furnished by beater addition.

It is evident that the stocks prepared by beater-addition of resin, when compared with stocks impregnated with phenolic resins off the machine or at the size press, are considerably tougher in both the dry and wet condition; approximately 100% improvement is shown for wet tensile. Moreover their original strength after creasing is retained, whereas it is shown that the impregnated papers lose from 35 to 100% of their original strength after creasing.

The majority of the developments described in this paper are beyond the development state and have been tested at semicommercial and commercial scales. A number are already in production. The authors wish to thank the paper industry as a whole for its cooperation without which these developments would not have been realized, and for their generous assistance in providing much of the technical data employed in preparing this paper.

Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 20–23, 1950.

RECENT BOOKS

Modern Packaging Encyclopedia (1950). The Packaging Catalog Corp., New York. Cloth. $8^1/_4 \times 11^1/_4$, 932 pages, charts, illustrated. Domestic $5.00, Canada $6.00, Foreign $7.00.

This remarkable book has come down through the years giving a record of the year by year advance in packaging materials and containers of all kinds. Many of the subjects considered in the 1950 edition were unheard of in the earlier editions. This is true, particularly in regard to the present use of many of the synthetic resins. Although the book is a catalog, primarily it deserves its designation as an encyclopedia. Among the subjects covered are package planning, the materials of packaging (wherein paper in its many forms plays an important part), package forms, machinery and equipment, shipping containers, and displays. Each of these subjects are expertly treated by individuals of many years of experience. A feature of the book is the number of useful charts contained therein. Among these are such titles as Product and Package Characteristics, Packaging Materials Tests, Properties of Basic Packaging Papers, Plastics for Packaging, etc.

Scientific Instruments II. Edited by Herbert J. Cooper, Head of Engineering Dept., South-West Essex Technical College and School of Art. Chemical Publishing Co., Brooklyn, N. Y. Cloth $5^1/_2 \times 8^1/_2$. 306 pages. Illustrated $6.00.

Eighteen British specialists discuss in detail a large number of instruments in the field of optics, astronomy, navigation, electricity, electronics, and sound. Among the subjects covered are lenses, cameras, illumination, infrared, valve circuits, electrical measuring, metals and fabrics. It is written for chemists, physicists, and research workers.

Gloss. Its Definition and Measurement. By V. G. W. Harrison. Chemical Publishing Co., Brooklyn, N. Y. 1949. Cloth $5^3/_4 \times 8^1/_2$, 145 pages. Illustrated. $4.00.

This is a monograph giving a critical study of the literature of gloss and luster. It is an attempt, as stated by the author, to prepare a comprehensive review of our present knowledge of the whole subject of "finish" of paper. The work is divided into four parts. The first two deal with the physical, physiological, and psychological factors that influence our sensation of gloss. Part three gives an account of the various attempts that have been made to get a practical measure of gloss and in Part four the author tries to sum up the present state of our knowledge and to show the difficulties that lie in the way of an exact specification of gloss and to indicate the lines along which progress may be made most rapidly, both in the research laboratory and in the plant. Finally he indicates the research plans relative to gloss that the PATRA laboratories expect to follow.

Handbook of Chemistry. Edited by Norbert A. Lange. Handbook Publishers, Inc., Sandusky, Ohio. 1949. Fabricoid. $5^1/_2 \times 8$. 1934 pages. $7.00.

Lange's Handbook of Chemistry which, in its seven editions over the past fifteen years, is too well known to require much more than an announcement that the 7th Edition is ready. It follows its regular pattern covering the elements, inorganic and organic compounds, analytical, physical, and industrial chemistry with the usual, but much more extensive tables and an unusually fine index. The latter is one of the most important assets of a handbook. The publishers are to be commended for providing the user with typography that can be read easily.

Surface Chemistry. Edited by the Faraday Society. In French and English. Interscience Publishers. New York. 1949. Cloth $7^1/_2 \times 10$, 334 pages. $6.00.

The chapters in this book were presented at a joint meeting of the Faraday Society and the Societe de Chimie Physique held at Bordeaux, Oct. 5–9, 1947 in honor of Prof. Henri Devaux. They were originally published as a supplement to *Research*, a Journal of Science and Its Applications. It is a book for advanced students of surface chemistry and contains such papers as Kinetics of Adsorption at Liquid/Liquid Interfaces; Effects of Salts on Soluble Ionized Monolayers; Surface Attack of Metals by Fatty Acids; Simple Experiments to Illustrate the Effect Upon Bacterial Growth of Mutual Precipitation in Mixtures of Colloidal Electrolytes.

GUIDE TO PROFESSIONAL SERVICES

CHAS. T. MAIN, INC.

CONSULTING ENGINEERS

Process Studies, Design, Specifications and Engineering Supervision

PULP AND PAPER MILLS

Steam Hydraulic and Electrical Engineering
Reports, Consultation and Valuations

80 Federal Street — Boston 10, Mass.

MYERS & ADDINGTON

Specialists for over 30 years in

INDUSTRIAL POWER PROBLEMS
ELECTRIC—STEAM—SURVEYS—DESIGNS
FOR
PULP AND PAPER MILLS

21 East 40th Street, New York 16, N. Y. — MUrray Hill 6-4630

RODERICK O'DONOGHUE

CONSULTING ENGINEER

PULP MILLS—PAPER MILLS

IMPROVED PROCESSES—DESIGNS—REPORTS

420 Lexington Ave. — New York 17, N. Y.

J. E. SIRRINE CO. *Engineers*

Greenville, S. C.

Est. 1902

Paper • Pulp Mills • Waste Disposal • Textile Mills • Appraisals • Water Plans • Steam Utilization • Steam Power Plants • Hydro-Electric • Reports

STADLER, HURTER & COMPANY

CONSULTING ENGINEERS

Specializing Since 1923 in

PULP AND PAPER MILLS

FROM FOREST TO FINISHED PRODUCTS

A. T. HURTER, M.E.I.C.
Suite 609
Drummond Building
Montreal, Canada

Represented in the U.S.A. by:
Stadler, Hurter & Co., Inc.
76 Beaver Street, New York 5, N. Y.
Phone: Whitehall 3-3881

FRANK C. VAUGHAN

Consulting Engineer

STUDIES, DESIGN, ESTIMATES, CONSTRUCTION, MANAGEMENT AND OPERATION
for
KRAFT, SEMI-CHEMICAL
PULP, PAPER AND STRUCTURAL BOARD MILLS

7th AND HOSPITAL STS. • RICHMOND, VA.

FREDERICK WIERK

CONSULTING ENGINEER

P. O. Box 492 — Great Neck, N. Y.

Reports and Designs for Construction or Modernization of Pulp & Paper Mills, Steam and Hydro Power, Stream Pollution Abatement.

Calendar of TAPPI Meetings

NATIONAL

Annual Meeting: Commodore Hotel, New York, N. Y., February 19–22, 1951.

Fundamental Research Conference: Chateau Frontenac, Quebec, P. Q., May 29–30, 1950. Symposium: "The Papermaking Properties of Fibers." (Joint Meeting with Technical Section, Canadian Pulp and Paper Association).

Second Testing Division Conference. Eastman Kodak Co. plant, Rochester, N. Y., September 13–15, 1950.

General Chairman—James D'A. Clark, Longview Wash.

Fibrous Materials Testing Committee—E. R. Schafer, Forest Products Laboratory, Madison, Wis., Chairman.

Nonfibrous Materials Testing Committee—J. P. Casey, New York State College of Forestry, Syracuse, N. Y., Chairman.

Wax Testing Committee—A. M. Heald, Marathon Corp., Menasha, Wis., Chairman.

Pulp Testing Committee—L. V. Forman, Institute of Paper Chemistry, Appleton, Wis., Chairman.

Optical Properties Committee—A. H. Croup, Hammermill Paper Co., Erie, Pa., Chairman.

Microscopy Committee—C. E. Brandon, Aetna Paper Co., Dayton, Ohio, Chairman.

Paper Testing Committee—A. K. Warner, Skinner & Sherman, Inc., 246 Stuart St., Boston, Mass., Chairman.

Container Testing Committee—W. J. Balster, Don L. Quinn Laboratories, Chicago, Ill., Chairman.

Chemical Methods Committee—Milton Fillius, Eastman Kodak Co., Chairman.

Packaging Materials Testing Committee—L. E. Simerl, Marathon Corp., Menasha, Wis., Chairman.

Fifth Engineering Conference of the Pulp and Paper Industry. Netherland Plaza Hotel, Cincinnati, Ohio, October 2–5, 1950.

Fibrous Agricultural Residues Conference, Peoria, Ill., November 12–13, 1950.

Alkaline Pulping Conference: George Washington Hotel, Jacksonville, Fla. October 25–27, 1950.

LOCAL SECTIONS

EMPIRE STATE SECTION:

Western New York Group:
May 10, 1950, Prospect House, Niagara Falls, N. Y.

Metropolitan Group:
May 9, 1950, Fraunces Tavern, New York, N. Y.

DELAWARE VALLEY SECTION:

April 27, 1950, Engineers Club, Philadelphia, Pa.

OHIO SECTION:

May 11, 1950, Manchester Hotel, Middletown, Ohio.

MAINE-NEW HAMPSHIRE SECTION:

June 23–24, 1950, Wentworth-by-the-Sea, Portsmouth, N. H.

KALAMAZOO VALLEY SECTION:

May 4, 1950, Harris Hotel, Kalamazoo, Mich.

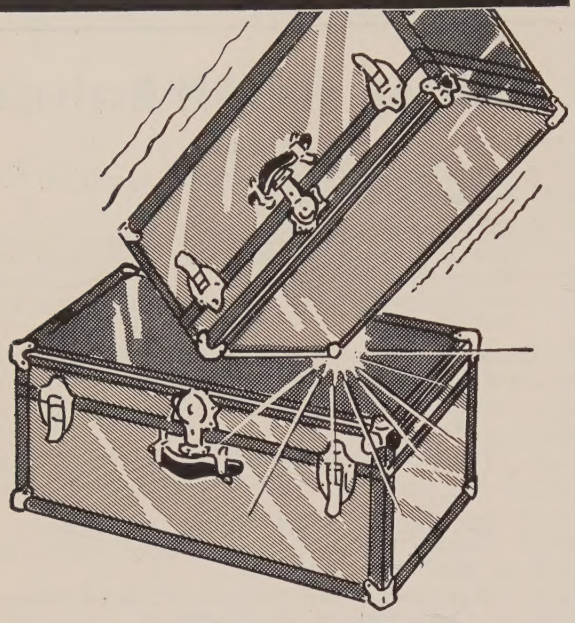
LAKE STATES SECTION:

May 9, 1950, Appleton, Wis.

LAKE ERIE PAPERMAKERS AND CONVERTERS ASSOC.:

April 21, 1950, Hickory Grille, Cleveland, Ohio
May 19, 1950, Hickory Grille, Cleveland, Ohio

TESTED IS TRUSTED



Testing Fibre Board

By utilizing the new *Scott Tester, Model J, luggage fibre board can be tested in accordance with established U. S. Government "Specifications for Deflection." By this test, material is evaluated for—

BRITTLENESS
PUNCTURE-RESISTANCE

Other models of *Scott Testers evaluate paper stock from cigarette paper to wallboard for tensile and stretch characteristics from

4 GRAMS TO 1 TON

REQUEST CATALOG 49

*Registered **SCOTT TESTERS** Trademark

SCOTT TESTERS, INC.

53 Blackstone St. Providence, R. I.

Standard of the World

INDEX TO ADVERTISERS

American Cyanamid Co. (Calco) ..... 2nd Cover
American Cyanamid Co. (Industrial) ..... 11 A
Ansul Chemical Co. ..... 81 A
Atlas Mineral Products Co. ..... 78 A

Babcock & Wilcox Co. ..... 36 A
Bauer Bros. Co. ..... 71 A
Beloit Iron Works ..... 1 A
Bird Machine Co. ..... 39 A
Black-Clawson (Shartle, Dilts) ..... 12 A
Buffalo Forge Co. ..... 6 A
Buffalo Pumps, Inc. ..... 10 A
Butterworth & Sons, H. W. ..... 77 A

Cowles Co. ..... 69 A
Curlator Corp. ..... 47 A

Dow Chemical Co. ..... 13 A
Draper Brothers Co. ..... 84 A
Du Pont de Nemours & Co. Inc., E. I. (Dyestuffs) ..... 2 A
Du Pont de Nemours & Co. Inc., E. I. (Electrochemicals) ..... 9 A
Du Pont de Nemours & Co. Inc., E. I. (Pigments) 35 A

Eastwood-Nealley Corp. ..... 73 A

Ferro Enamel Corp. ..... 85 A
Fischer & Porter Co. ..... 75 A
Foster Wheeler Corp. ..... 3 A

Glidden Co., The ..... 59 A
Gottesman & Co. ..... 49 A
Gurley, W. & L. E. ..... 83 A

Hermann Manufacturing Co. ..... 27 A
Hooker Electrochemical Co. ..... 63 A
Huyck & Sons, F. C. ..... 8 A

International Nickel Co. ..... 33 A

Johns-Manville Corp. ..... 29 A
Jones & Sons Co., E. D. ..... 61 A

Langston Co., Samuel M. ..... 19 A

Mallinckrodt Chemical Works ..... 83 A
Mathieson Chemical Co. ..... 7 A

National Starch Products, Inc. ..... 25 A
NOPCO Chemical Co. ..... 41 A
Norton Co. ..... 53 A

Oakite Products, Inc. ..... 89 A
Oliver United Filters, Inc. ..... 80 A
Orr Felt & Blanket Co. ..... 67 A

Paper & Industrial Appliances, Inc. ..... 48 A
Philadelphia Quartz Co. ..... 74 A
Pittsburgh Plate Glass Co. ..... 4th Cover
Pusey & Jones Corp. ..... 4 A

Raybestos-Manhattan Inc. ..... 17 A
Rohm & Haas Co. ..... 23 A

Scott Testers, Inc. ..... 92 A
Sindar Corp. ..... 79 A
Solvay Sales Div., Allied Chem. & Dye Corp. ..... 43 A
Sprout, Waldron & Co. ..... 31 A
Stebbins Engineering & Mfg. Co. ..... 87 A
Stein, Hall & Co. Inc. ..... 76 A
Swenson Evaporator Co. ..... 65 A

Texas Gulf Sulphur Co. ..... 55 A
Titanium Pigment Co. ..... 3rd Cover
Tracerlab, Inc. ..... 51 A

Vanderbilt Co., R. T. ..... 15 A

Wallace & Tiernan Co., Inc. ..... 57 A
Weyerhaeuser Timber Co. ..... 21 A
Wyandotte Chemical Corp. ..... 45 A

PROFESSIONAL SERVICES

Main, Chas. T., Inc. ..... 91 A
Myers & Addington ..... 91 A
O'Donoghue, Roderick ..... 91 A
Sirrine & Co., J. E. ..... 91 A
Stadler, Hurter Co., Ltd. ..... 91 A
Vaughan, Frank C. ..... 91 A
Wierk, Frederick ..... 91 A

Packages pigmented with Titanox STAND OUT

Titanox pigments build arresting quality into many kinds of paper stock. They increase visibility, legibility and add sales-impelling package-appeal by: 1.) producing white, bright and opaque papers and lined board that resist yellowing—minimize show-through. 2.) producing sharp, clear tints. 3.) maintaining equal opacity and brightness in light and heavy stock. 4.) increasing opacity at constant brightness.

Titanox pigments are equally applicable to beater-pigmented papers, tub and calender sized stock and coated stocks. Their uniform fineness assures easy, complete dispersion, speeds production and lowers costs.

For beater-pigmented stocks, TITANOX-A-WD or TITANOX-A-MO are preferred. In tub or calender sizing, TITANOX-A or TITANOX-RCHT are the pigments of choice. For coated stocks whether clay, wax or resin emulsion, either TITANOX-A or TITANOX-RCHT are recommended.

Our Technical Service Department is always ready to serve as a partner in solving your paper pigmentation problems. Write us today for further information. Titanium Pigment Corporation, 111 Broadway, New York 6, N. Y.; 104 South Michigan Avenue, Chicago 3, Ill.; 2600 South Eastern Avenue, Los Angeles 2, Calif. Branches in all other principal cities.

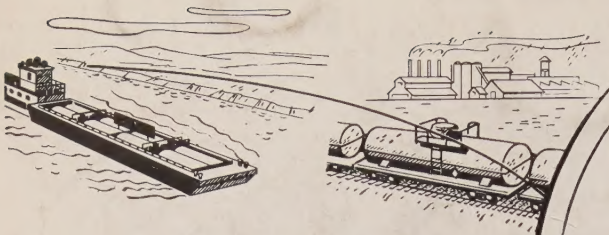
® TITANOX

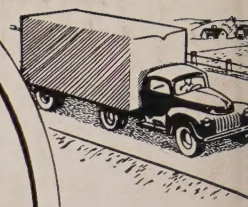
the brightest name in pigments

TITANIUM PIGMENT CORPORATION

Subsidiary of NATIONAL LEAD COMPANY

57





COLUMBIA CHEMICALS

Always CHECK with COLUMBIA for your Chemical needs

Looking beyond the price tag, you'll find it advantageous to check Columbia for alkalies, chlorine and related chemicals. The consistent high quality of Columbia products is backed by Columbia facilities and services that should be important considerations in your chemical buying. Pittsburgh Plate Glass Company, Columbia Chemical Division, Fifth at Bellefield, Pittsburgh 13, Pa.

COLUMBIA OFFERS THESE ADVANTAGES

- Conveniently located plants
- Adequate production capacity
- Meticulous attention to your requirements
- Speedy delivery
- Technical service
- Trained, skilled personnel
- Over a half-century's experience

SODA ASH
CHLORINE
CAUSTIC SODA
SODIUM BICARBONATE
CALCIUM CHLORIDE
CAUSTIC ASH
MODIFIED SODAS
SODA BRIQUETTES
(Iron Desulphurizer)
PHOSFLAKE
(Bottle Washer)
SILENE EF
(Hydrated Calcium Silicate)
CALCENE T
(Precipitated Calcium Carbonate)
HI-SIL
(Hydrated Silica)
PACIFIC CRYSTALS
(Sodium Sesquicarbonate)
BORAX
PARA-DICHLOROBENZENE
ORTHO-DICHLOROBENZENE
MONO-CHLOROBENZENE
BENZENE HEXACHLORIDE
PERCHLORETHYLENE
MURIATIC ACID

COLUMBIA CHEMICALS

CHICAGO • MINNEAPOLIS • BOSTON
NEW YORK • CINCINNATI

ST. LOUIS • CHARLOTTE • PITTSBURGH
CLEVELAND • PHILADELPHIA

PAINT • GLASS • CHEMICALS • BRUSHES • PLASTICS

PITTSBURGH PLATE GLASS COMPANY